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Journal of the Bombay Natural History Society

Vol. 58, No. 1

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H. SANTAPAU, S.J., & HUMAYUN ABDULALI

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EDITORS,
Journal of the Bombay Natural History Society.

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CORRIGENDA

Vol. 58, No. 1—April 1961

In the paper entitled 'The Moss Flora of the Palni Hills', the following names should have been printed in bold face capitals :

Page 29 : **TRIGONODICTYON**
Page 34 : **HOMALIOPSIS**
Page 41 : **NANOTHECIUM**
Page 42 : **FOREAUELLA**

Vide explanation on page 14 of the same *Journal.*

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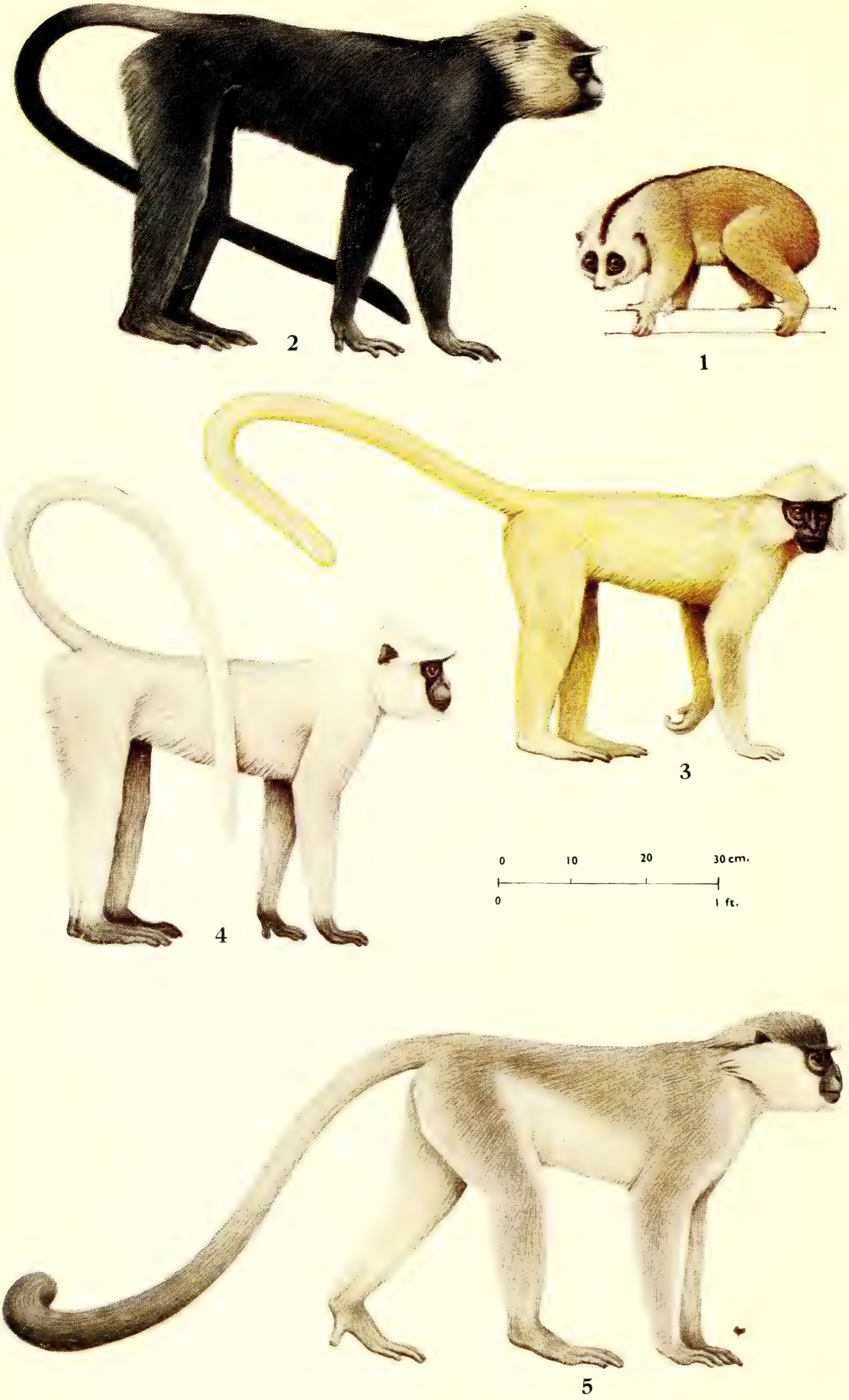

1. The Slow Loris, *Nycticebus coucang*; 2. The Nilgiri Langur, *Presbytis johni*; 3. **The Golden Langur,** *Presbytis geei*; 4. The Common Langur, or Hanuman Monkey, *Presbytis entellus*; 5. The Capped Langur, or Leaf Monkey, *Presbytis pileatus.*

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1961 APRIL Vol. 58 No. 1

The Distribution and Feeding Habits of the Golden Langur, *Presbytis geei* Gee (Khajuria, 1956)

BY

E. P. GEE, M.A., C.M.Z.S.

(*With two maps and three plates*)

INTRODUCTION

As there was still a very great deal to be learnt about the distribution and habits of the recently described Golden Langur (*Presbytis geei* Gee) I decided to re-visit north-west Assam, and also for the first time the Garo Hills, for further field studies. My grateful acknowledgements are due to the Bombay Natural History Society for a financial grant (from funds made available by the Rockefeller Foundation) towards the cost of these expeditions and the field work involved.

My itinerary included the following places in Assam: north-west Goalpara District November 19th to December 1st 1959, North Kamrup District December 2nd to 15th 1959, North Kamrup District February 17th to 27th, and Garo Hills March 24th to 25th and April 20th to 29th 1960.

The history of the discovery of this new langur is briefly as follows. A number of sportsmen and Forest Officers had noticed a cream-coloured langur in the vicinity of Jamduar F.R.H. (Forest Rest House) on the east bank of the Sankosh River near the boundary of India and Bhutan. Probably the first to do so and to report it was E. O. Shebbeare in 1907, but no photographic record and no live or dead specimen was then obtained for examination.

In 'A Tentative List of the Vertebrates of the Jalpaiguri District, Bengal' Chas. M. Inglis, W. L. Travers, H. V. O'Donel, & E. O. Shebbeare (1919) make the following reference to the subject of this paper: '*Pithecus* sp?—A pale yellow coloured langur is common in the adjoining district of Goalpara (Assam). Jerdon reported one from the Terai, the adjacent district on the (west) side, which Blanford suggested might be *P. entellus*. Recently we have heard of another observed in the Terai.'

In the visitors' book of the Raimona F. R. H. (not far from Jamduar) is an entry by C. G. Baron dated 26-2-47: 'I saw some white monkeys (langurs) on the Ranga on 25th. The only other place I have seen this variety (or species) is on the Bhutan border in the North Kamrup Game Sanctuary and so far as I know they are an unidentified species. The whole body and tail is one colour—a light silvery-gold, somewhat like the hair of a blonde.' H. E. Tyndale also recorded on 23-2-48 in the Jamduar F. R. H. visitors' book that he 'saw Sankosh cream langurs'. Tyndale and another north Bengal tea planter, A. V. Pullan, both informed me personally about the existence of this cream-coloured langur at the River Sankosh, and I determined to investigate at the earliest opportunity.

Incidentally it should be mentioned at this point that there is a marked seasonal variation in the colour of this langur. The description 'cream-coloured' or 'white' is correctly applicable in the warmer weather from the end of February onwards, when they get their hot weather coats. In the colder weather from November to February they become definitely darker with a rich golden or chestnut-coloured tinge.

Accordingly I visited Jamduar on the Sankosh River from November 16th to 25th 1953. I found one troupe of these cream-coloured or golden langurs on the Bhutan side of the boundary, between Maure ('Bhutan bustee') village and the river, and another larger troupe of about 30-40 langurs about one mile (*c*. 1.6 km.) north of the bungalow. A third troupe was seen by my companions about four or five miles (*c*. 6 or 8 km.) downstream, actually on the shingle of a dried-up channel as they crossed from the main river back into the forest. The second of the above troupes was cine-filmed by me on several occasions. All three troupes were on the east bank of the river.

In August 1954 I reported the existence of these golden langurs to Dr. W. C. Osman Hill of the Zoological Society of London, and he considered that they might be a new species. Also I reported their existence to the Zoological Survey of India in January 1955, when I showed my cine-film of them, and suggested that the Survey Party then working in Bengal should visit Jamduar in order to collect specimens for examination. Dr. S. L, Hora, then Director of the Zoological Survey of India, showed keen interest in my report, and instructed the Survey Party to include Jamduar and the cream-coloured langur in their itinerary.

The Survey Party duly collected six specimens of the langur, and H. Khajuria in his description of it as a new species was kind enough to name it after me as *Presbytis geei*, a compliment (?) which I gratefully (though very humbly) acknowledge. It was unfortunate that this new name came to be inadvertently included in a short Miscellaneous Note written by me and published in the *Journal of the Bombay Natural History Society*, Vol. 53 pp. 252-254 in December 1955, actually prior to the publication of H. Khajuria's scientific description of the langur as a new species in the *Annals & Magazine of Natural History*, Ser. 12, Vol. 9, pp. 86-88, in February 1956. Of the six specimens collected, a topotype was donated to the British Museum.

In the spring of 1957 a party known as 'The German-India Expedition 1955-1957' visited Jamduar and Raimona, and found eleven troupes of *Presbytis geei* in that neighbourhood. H. Khajuria accompanied that expedition.

In the map published with my Miscellaneous Note in 1955 I gave the Ranga stream as the eastern limit of the range of this new langur. Subsequently, however, I received information from M. A. Islam, then Divisional Forest Officer of Goalpara West Division, that he had observed a troupe of 7 or 8 of 'these golden-coloured langurs' nearly two to three miles (*c.* 3 to 4 km.) east of the Ranga. Islam also drew my attention to Baron's entry in the visitors' book about his having seen these langurs in the North Kamrup (Manas) Game Sanctuary, and informed me that Baron had told him personally that he had seen them on the Gabrukunda side of the river, i.e. on the west side of the Manas. This information that *P. geei* occurred as far east as the west bank of the Manas River was later confirmed by H. R. D. Robey in 1958 who saw 'troupes of the golden langur on two occasions, on the west bank of the river, whilst going upstream . .'. Although I myself camped on the Manas River in November 1949 and again in February-March 1952, I had not observed any signs of the new langur but had only seen and filmed several troupes of a rather dark race of *Presbytis pileatus* (later identified as *P. pileatus tenebricus* Hinton, 1923) on the east bank of the river.

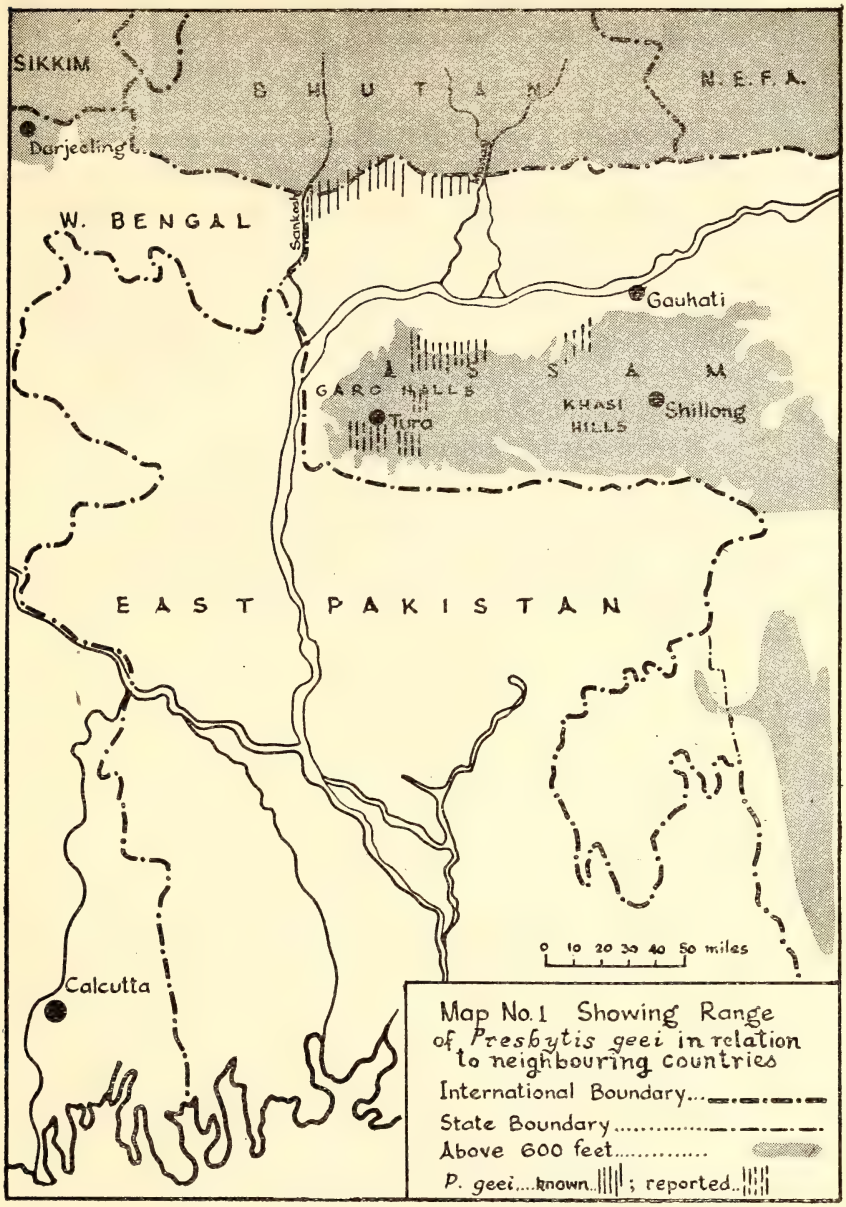
Two live specimens of *P. geei* were sent from Raimona to the Gauhati Zoo in Assam. One had been kept as a young one by Range Officer, Gogoi, and was seen and photographed by the German-India Expedition there in the spring of 1957. Another was caught in September 1957. Both these were in the Gauhati Zoo in 1958, but the larger one (a male) died on May 2nd 1958 and is now roughly stuffed and exhibited in the Forest Museum of that town. The younger one was photographed by me when about one year old, together with a live specimen of *P. pileatus pileatus* from Darugiri in the Garo Hills, in September 1958. It died on 25-11-58. As so little was known of the feeding habits of this langur, it is not surprising that both these specimens lived only a short time in captivity.

In addition to the known habitat of *P. geei* in the vicinity of the Sankosh and Ranga rivers, and to the reported existence of this langur on the west bank of the Manas River, there had from time to time been reports of the existence of *P. geei* in parts of the Garo Hills also, to the south of the Brahmaputra River.

NORTH-WEST ASSAM, NOVEMBER 1959 TO FEBRUARY 1960

It was against the above background that I decided to do a series of quick field surveys, in order to find out the full distribution and also the feeding habits of this new species. Accordingly I travelled to NW. Goalpara in November 1959, and spent the first day at Bamba F.R.H., which is about 18 miles (*c.* 28 km.) due east of Jamduar. I had with me a postcard-sized colour print of *P. geei,* and a mounted colour transparency of the same langur together with the *P. pileatus pileatus,* as photographed in the Gauhati Zoo. These I showed to the various Forest Department staff and others as I travelled around, advising all concerned of the necessity of accurate and first-hand information and so on. The news collected at Bamba was that ten to twelve troupes of *P. geei,* of about 15 langurs in each, were believed to exist in that neighbourhood (the Sanfan Forest Range), and that the Common Langur, *P. entellus,* and the Capped Langur, *P. pileatus,* did not exist in those parts. The above information was confirmed by the Range Officer of Raimona, M. N. Adhikary. I and my party did not actually observe any langurs in that area, partly owing to disturbance by labourers working on or near the forest roads.

I then moved to Jamduar, where I camped for eleven days. In this area I and my party observed from time to time six different


SIKKIM
BHUTAN
N.E.F.A.
Darjeeling
W. BENGAL
Sankosh
Gauhati
ASSAM
GARO HILLS
Tura
KHASI HILLS
Shillong
EAST PAKISTAN
Calcutta
0 10 20 30 40 50 miles
Map No. 1 Showing Range of *Presbytis geei* in relation to neighbouring countries
International Boundary
State Boundary
Above 600 feet
P. geei....known; reported

troupes of *P. geei*, each in number varying from 10 to 20 langurs. Young babies were seen in most troupes, apparently about 2-3 months old then, that is born about August or September. This was later confirmed by M. N. Adhikary, who stated that the second *P. geei* sent to the Gauhati Zoo was captured on September 15th 1957 and was then believed to be only one month old and in the early suckling stage.

The young ones were observed to be much lighter in colour than the adults, and this was confirmed by the Forest staff who stated that the very young babies are almost white in colour. There were several reports of 'pure white' troupes of *P. geei* having been seen but further interrogation revealed that these were seen in the hot weather, and so I do not attach any special importance to these reports. No Capped Langurs or Common Langurs were seen anywhere round here.

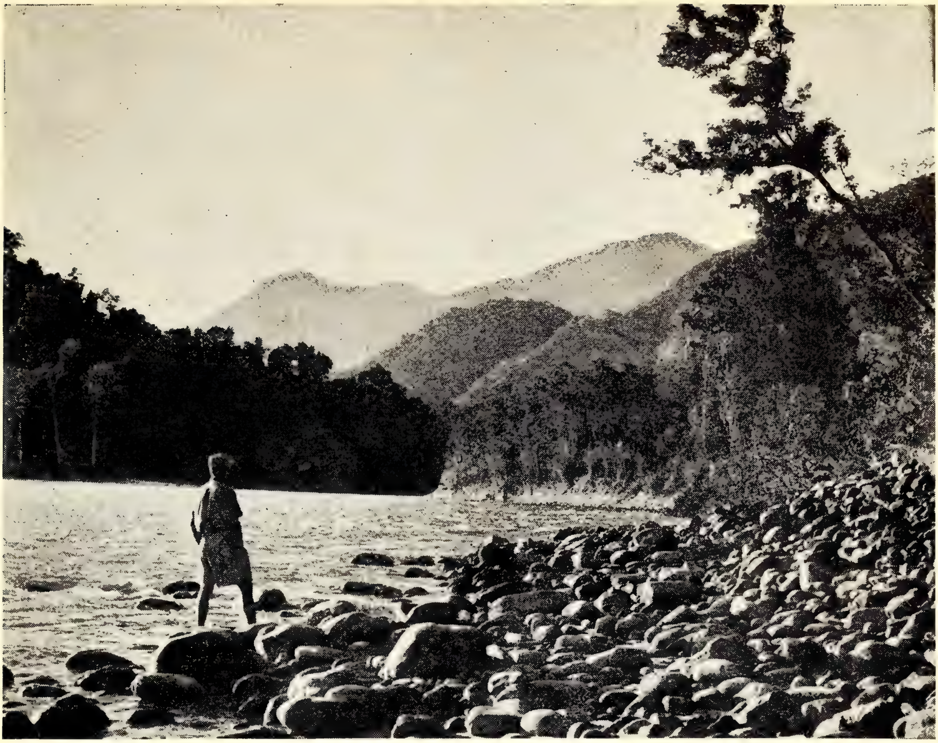
While watching one of the above troupes one mile (*c.* 1.6 km.) north of Jamduar, near Maure village, we saw a few rhesus monkeys *Macaca mulatta* in the rice fields feeding on the ripening corn. The village headman and others immediately confirmed that *P. geei* never descend to the ground to raid human cultivations in this manner. During our observations in November 1959 we observed *P. geei* feeding on the buds, leaves, flowers, of fruit of the following trees, of which the local (mainly Assamese) names are also given:

Terminalia belerica	bhomra-bohera
Cedrela toona	jati poma
Lannea grandis	jia poma
?	katakursi, katakuschi
Albizzia lebbek	koroi
Ficus sp.	dumbaroo
Bischofia javanica	uriam
Gmelina arborea	gomari
Oroxylum indicum	bhatghila
Salmalia malabarica	simul

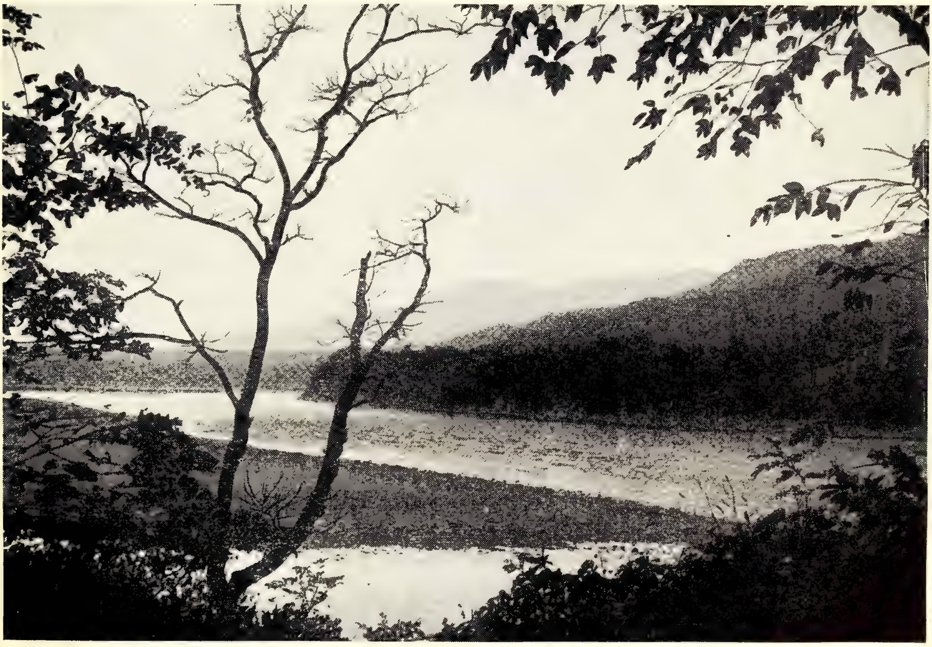
On December 2nd 1959 I moved to the Manas River and camped at Motharguri for two weeks. The local Forest staff confirmed that *P. geei* existed on the west side of the river (and not on the east side) and that *P. pileatus* existed on the east side (and not on the west side). It was not long before we ran into several troupes of *P. pileatus tenebricus* on the east side of the river. These were filmed, on several occasions, as they fed on the buds of *Salmalia malabarica* (simul).

On December 10th we looked for *P. geei* on the west side of the river, and succeeded in locating a troupe variously estimated at 20-40 langurs. They were very shy and could not be filmed, and the forest was very thick and hilly at this place on the boundary of India and Bhutan.

On February 17th 1960 I returned to the Manas to continue my field observations, and on 18th at 1.30 p.m. observed 7 *P. geei* at the

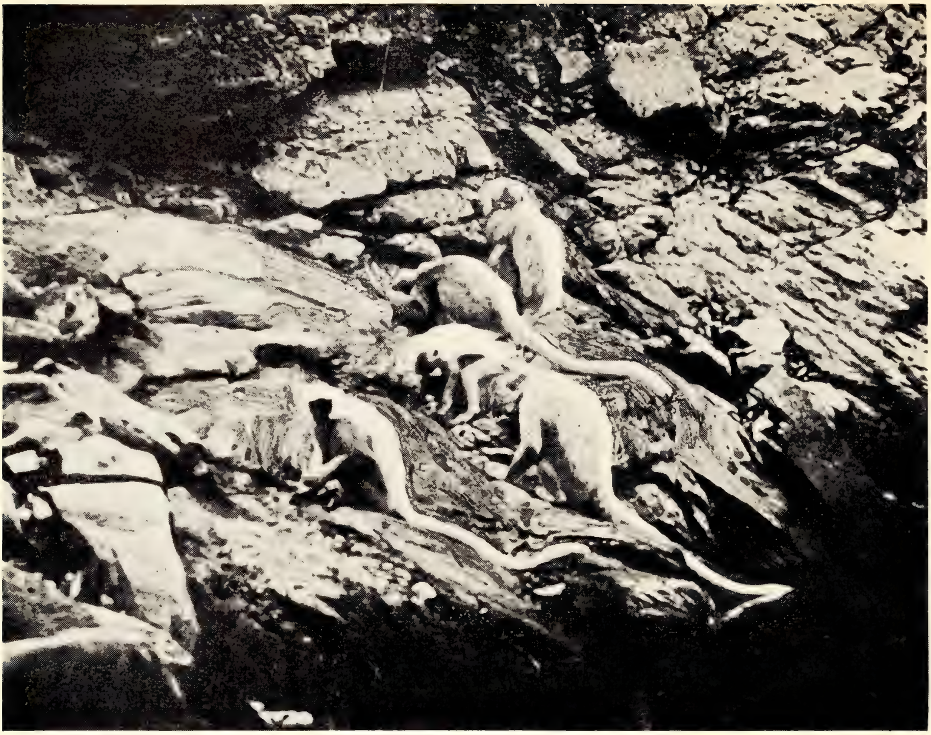


The River Sankosh as it flows out of Bhutan. This is the westernmost limit of *Presbytis geei,* a troupe of which lives in the forest at the right of the photograph.

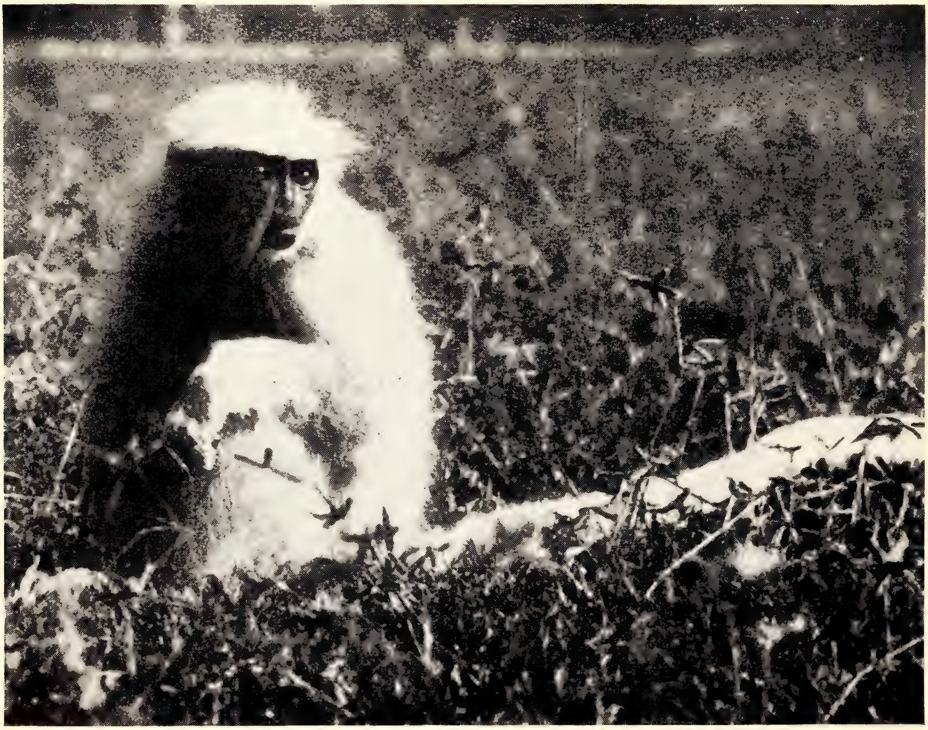


Looking westwards across the River Manas, which is the easternmost limit of *P. geei*. In the forest just across the river this langur is found.

Photos : E. P. Gee



Some of the troupe of seven *P. geei* observed eating salty earth on the bank of the Manas River, above Motharguri



Presbytis geei about one year old, in the Gauhati Zoo

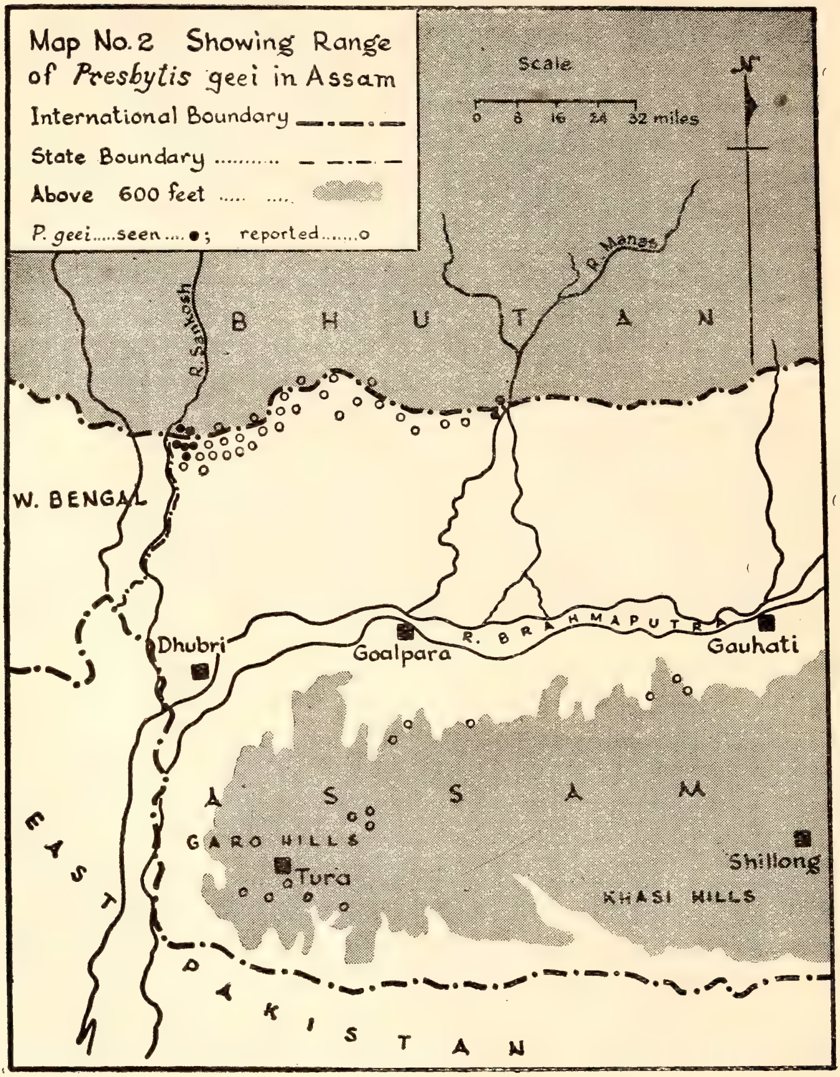
Photos : E. P. Gee

river's edge upstream from Motharguri, on the west bank, near the Bhutan border. After they had disappeared into the forest we crossed over by boat and erected my cloth 'hide' near the spot. On 20th a watch was kept in the hide from 11 a.m. to 3 p.m. but no langurs came. On 22nd the 7 langurs came from 2 to 2.30 p.m., and cine film and still photographs were obtained of them as they ate salty earth with their mouths. Only two of them drank water. They appeared to be paler in colour than the Sankosh ones, with no golden or chestnut-coloured patches. There was a mother with a lighter coloured baby among them. On 23rd they did not come, and on 24th I moved to Bhuyapara camp at the western end of the Manas Sanctuary, where we saw many troupes of *P. pileatus tenebricus.*

Other visitors to the Manas River have recently seen this small troupe of 7-9 *P. geei* on the western bank of the river, north of but not far from the Bhutan boundary, as well as the larger troupe variously estimated up to 40 langurs, which is usually south of the boundary. It is not clear whether the 7 *P. geei* seen were a separate troupe or a fragment of the larger troupe. In sketch map No. 2 I have given a conservative estimate of two troupes of 15 each seen here, and have marked them with solid dots as well as the six troupes (averaging 15 langurs each) actually seen near Jamduar on the Sankosh River. Other troupes reported to have been seen in between these two rivers, including the other five troupes seen by the German-India Expedition in 1957, have been shown as hollow dots. It is only reasonable to presume that, as the existence of *P. geei* in the areas east of the Sankosh and west of the Manas has now been proved, and as there are no geographical barriers in the way, the reports of their existence in the intervening forests should be true. It is difficult to obtain any accurate information as to how far *P. geei* extends northwards into Bhutan, but the Bhutan District Officer whom I met near Jamduar assured me that he had never heard of them further north than near Maure village, and this was confirmed later by the Maure village headman.

E. O. Shebbeare, H. E. Tyndale, and A. V. Pullan have informed me that certainly no *P. geei* have ever been observed west of the Sankosh River in north Bengal—in fact no langurs of any kind seem to be found in north Bengal until the Teesta River much further westwards.

The numbers of *P. geei* in existence in north-west Assam, between the rivers Sankosh and Manas, including the area just north of the India-Bhutan boundary, I conservatively estimate as thirty-six troupes


Map No. 2 Showing Range of *Presbytis* geei in Assam
International Boundary
State Boundary
Above 600 feet
P. geei.....seen.... ●; reported.......○
Scale
0 8 16 24 32 miles
N
R. Sankosh
R. Manas
BHUTAN
W. BENGAL
Dhubri
Goalpara
R. BRAHMAPUTRA
Gauhati
ASSAM
GARO HILLS
Tura
Shillong
KHASI HILLS
EAST PAKISTAN

averaging 15 langurs in each, that is a total of 540 langurs. (See map No. 2.)

THE GARO HILLS, MARCH-APRIL 1960

On March 24th and 25th I visited Loharghat and Khulsi Forest Ranges in the Khasi Hills adjacent to the north-east portion of the Garo Hills, and showed the colour pictures of langurs to various Forest staff, contractors, and others. The consensus of opinion was that *P. geei* existed in those parts, but none could be found in the short time available.

On April 19th and 20th I visited Boko Forest Range and Damra and Thapa, and questioned all the Forest staff I could meet. They were uncertain about the existence of *P. geei* in those actual parts, but several persons stated that they had seen this cream-coloured langur in Rengrengiri Forest and on the Tura Ridge.

While at Darugiri on April 21st to 23rd, Rongjeng and Nangalbibra were visited but no information on *P. geei* was obtained beyond what I had heard previously. A small troupe of *P. pileatus pileatus* was observed about one mile (*c*. 1.6 km.) from the Darugiri F.R.H., very light in colour and similar to the one photographed in the Gauhati Zoo.

On April 24th I journeyed to Songsak, Krishnai, and Goalpara town. Then on 25th to Rongsai, where a troupe of 10 *P. pileatus* (*tenebricus* ?) was seen, and to Haloidonga and Phulbari. The following day I went to Tura, the administrative centre of the Garo Hills, where I camped with P. C. Gogoi, the Divisional Forest Officer. Reports continued to be received of the existence of *P. geei* in the Rengrengiri Forest, which was rather inaccessible at the time owing to new road construction and impending rainy season, and on the Tura Ridge. Two trips up to the Tura Ridge proved unfruitful.

On April 28th I moved on to Singrimari, and back to Krishnai and Damra, and on 29th back to Shillong. The result of this quick expedition was disappointing in that I and my party actually did not observe any *P. geei*, but I am convinced that this species does exist (in small numbers, at least) in these Khasi Hills and Garo Hills, not so much because of the foregoing reports but for the following reasons:

1. B. Mitchell, an experienced sportsman who knows the Jamduar and Raimona area well and who has known *P. geei* there for a number of years, informs me that he was at Garupara village about 7 miles (*c*. 11 km.) east of Ranigodam F.R.H. in the Khasi foothills (adjacent to the Garo Hills) in March 1955, and came across a troupe of 8 or 9 *P. geei* which became very alarmed at the sight of his Labrador dog. He confirms that these langurs were exactly the same as the ones at the Sankosh River.

2. G. D. Munro, an experienced animal dealer of Calcutta, informed me in January 1956 that he had seen *P. geei* in the Rengram Forest of the Garo Hills, and that he once actually captured two of them there and sent them to the Milan Zoo, but they died on the

way. As Munro had seen the skins of *P. geei* collected by H. Khajuria, it is likely that his information is accurate.

3. In 1956 a very experienced animal catcher of Assam, Nokul Sarkar, visited me and was shown my cine film of *P. geei* (made at the Sankosh River in 1953). He instantly recognised the langur, and was quite definite that he had personally seen it in the Khulsi Forest Range and in near-by parts of the Garo Hills.

In maps No. 1 and 2, therefore, I have shown fourteen troupes averaging 15 langurs each of *P. geei* as 'reported' in the Garo Hills and a portion of the Khasi Hills. It is hoped that in the not far distant future I may be able to obtain more definite evidence as to the existence of this new species in these hills south of the Brahmaputra.

NEED FOR MORE INFORMATION

Throughout my trips to NW. Assam and into the Khasi Hills and Garo Hills I was severely handicapped by the fact that the local people, including the subordinate members of the Forest Department staff, possessed very little knowledge of natural history in general and of langurs in particular. Added to this, the local ideas of colour differences and the local words used to express colours, are very vague indeed. Consequently it was extremely difficult to explain in any language the difference between the Common Langur, *P. entellus*, the Capped Langur, *P. pileatus*, and the Golden Langur, *P. geei*. Moreover, in the Khasi and Garo hills there also exist Whitebrowed Gibbons or Hoolocks, *Hylobates hoolock*, the females of which are cream- or buff- coloured, and this added to the confusion.

I therefore consider it essential that in any future investigation the local people should be shown coloured pictures of all three above species of langur, and also if possible the female Hoolock, all drawn to the same scale. A colour plate accompanies this note, and I have added the details of the information wanted in the form of a questionnaire, to be published as an appendix to this note. The staff of the Forest Department can do a very great deal to assist in the collection and compilation of information, as this Department is well organized into Divisions, Ranges, Beats, and Sub-beats throughout the region concerned; and they alone are competent to identify the trees on which the langurs feed at different times of the year.

ACKNOWLEDGEMENTS

In conclusion, I offer my grateful acknowledgements for much help received during my expeditions to the officers and personnel of the Assam Forest Department, in close association with whom I have been working for many years.

APPENDIX

INFORMATION WANTED ON THE GOLDEN LANGUR, *PRESBYTIS GEEI*

From personal observation and from information received from various sources, this new species of langur is found:

1. Definitely in Goalpara and North Kamrup districts of Assam, between the rivers Sankosh and Manas, in a strip of country along the Bhutan border. It is probably more common at the Sankosh end than at the Manas end. It has not been observed west of the Sankosh or east of the Manas, but occurs at least a mile (*c.* 1.6 km.) or so north of the border into Bhutan.

2. Probably in the Garo Hills, for example at Ranigodam, Damra, Krishnai, Rengrengiri, and along the hills of the Tura Ridge.

Owing to extreme light colour, almost white in its hot weather coat and creamy gold in its cold weather coat, it is known in Goalpara as the *sada hanuman* or white langur. It should not be confused with the Common or Grey Langur (*sai barunia hanuman*) or with the Capped Langur (*lal hanuman*).

It is found in groups or 'troupes' of varying size, from about 10 to 25 or even more.

As it occurs almost exclusively in Reserved Forests, information as to its numbers, range and habits can best be obtained with the assistance of the Forest Department. If each Divisional Forest Officer could arrange for his Range Officers to find out the required information, including the approximate numbers of 'troupes', with approximate size of each 'troupe', in their respective Ranges at a particular time of the year, a fairly accurate estimate of the total population of this new and interesting species could be made.

Several specimens have from time to time been captured and kept in captivity. But these, though they quickly became tame, have always died due to lack of information as to their natural food. It is, therefore, most important to ascertain which trees (buds, leaves, flowers, fruit, etc.) it is found feeding on at different times of the year.

QUESTIONNAIRE ON *Presbytis geei*

Answers to the following questions are urgently required:

1. Which trees, and which parts of these trees, form its main food supply at different times of the year?

2. How many 'troupes', and of what sizes, are in existence in a particular Range, or Block, or other such clearly defined area?

3. At what time of the year are the young born?

4. Exactly what colour are the newly-born young?

5. Is the Grey Langur (*sai barunia hanuman*) or Capped Langur (*lal hanuman*) also found in the same area as *Presbytis geei* (*sada hanuman*)? If so, do they intermingle, or do they always keep separate?

6. Does each 'troupe' of *P. geei* remain within a particular locality, or 'territory', into which other 'troupes' will not enter? If so, does this 'territory' vary at different times of the year?

7. Does this species of langur migrate anywhere at any particular season, say in the hot weather higher up into the hills?

8. Is there also a pure white variety of this langur, with complete absence of cream or gold colour? If so, does it mix with the others, or does it keep apart in a separate 'troupe'?

9. Any other information as to the status, numbers, habits, etc., of this species.

Any information obtained on the above lines should be sent (either direct or through a superior officer) to Mr. E. P. Gee, Evergreen Cottage, Upper Shillong, Assam, who will be glad to compile and eventually publish (with due acknowledgements) whatever is received by him.

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The Moss Flora of the Palni Hills

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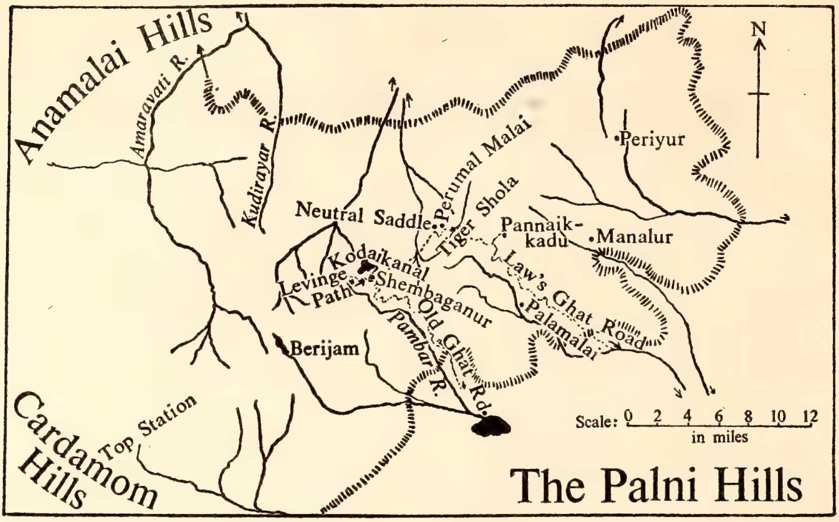
(*With a map*)

INTRODUCTION

The Palni Hills, in south India, are too well known to botanists to need any elaborate introduction here. Since the turn of this century, there have been occasional publications on the angiospermic flora of these hills, but the cryptogamic flora remained largely unknown. It is the purpose of the present paper to summarize the work done on the Moss Flora of the Palni Hills during the last fifty years.

The exploration work was initiated in 1908 by G. André, S.J., and J. Queste, S.J., and continued by A. Vellé, S.J., G. Roiné, S.J., and the present author, all then resident at the Sacred Heart College, Shembaganur. The collections were identified by M. Cardot, H. N. Dixon, and R. Potier de la Varde. Among these mosses many were new to science. These hitherto undescribed mosses, consisting of 4 genera, 95 species, and 15 varieties, were described by Potier de la Varde in 1922, 1923, 1924, 1925, and 1928, and by Dixon & Potier de la Varde in 1927 and 1930. The present author published, in 1930, a conspectus of mosses for the then Presidency of Madras, bringing together all the findings of the five-man team just mentioned. Since then, he has been working on his own, often assisted by generations of willing and enthusiastic Jesuit students of the Sacred Heart College, Shembaganur, and has been confining himself exclusively to the Palni Hills, often only during spare moments in the midst of more pressing duties, or sometimes only during the summer holidays. All additional data obtained therefrom regarding the distribution of mosses in the area under study are incorporated into the present paper. A map, showing the various places where collections were made, is included. The author's herbarium is lodged in the Museum of the Sacred Heart College, Shembaganur.

In the enumeration that follows, Families are arranged as in Brühl, 1931. Within each family, both genera and species are given in alphabetical order. The derivation of the generic name, in most cases, from Greek or Latin as the case may be, is given, following Dixon, 1954. The


Anamalai Hills
Amaravati R.
Kudirayar R.
N
Perumal Malai
Periyur
Tiger Shola
Neutral Saddle
Pannaik-
kadu
•Manalur
Kodaikanal
Levinge
Path
Shembaganur
Law's Ghat Road
Palamalai
Berijam
Pambar R.
Old Ghat Rd.
Top Station
Cardamom Hills
Scale: 0 2 4 6 8 10 12
in miles
The Palni Hills

name of the chief author, Potier de la Varde, is abridged as Varde. The genera first described for this area are given in bold face type ; all species and varieties originally described as new taxa for these parts of India are preceded by an asterisk (*) ; *all* the other species, *except* those few preceded by a dagger (†), are *new records*, as far as is ascertainable, for the Palni Hills. These few earlier records are by C. E. C. Fischer (Dixon, 1914). The altitudes given in the enumeration are only approximate. It has been possible to give references to publications only of the species first described for our area. It is regretted that it has not been possible to bring the nomenclature up- to- date, on account of insufficient literature at hand.

The author notes with great pleasure that the Editors are thinking of republishing the original descriptions of species from the Palni Hills, as contained in Potier de la Varde, 1922, 1923, 1924, 1925, and 1928, and Dixon & Potier de la Varde, 1927 and 1930. While thus resuming the work on the Moss Flora of the Palni Hills for the past half century, it is the author's sincere desire, in the evening of his life, that Indian bryologists should make use of these publications for further research and subsequently publish a comprehensive Moss Flora of India. If the author's attention to mosses during the past fifty years contributes, in some little measure, towards the realization of this *Muscologia Indica*, he will consider his efforts amply rewarded.

ENUMERATION OF SPECIES

I. FISSIDENTACEAE

Fissidens Hedw.

(From the Latin *fissus* = split, *dens* = a tooth, with reference to the peristome teeth)

1. **F. aberrans** Broth. & Dix.
Perumalmalai at 1600 m. 1920 ; Manalur at 1232 m. 1926.

*2. **F. angustiusculus** Dix. & Varde in *Arch. Bot.* 1 : 163, 1927.
Kodaikanal, Villupatti Paddy fields, at 1892 m. 1926.

3. **F. anomalus** Mont.
Kodaikanal at 2133 m. 1959.

4. **F. asplenioides** (Sw.) Hedw.
Perumalmalai at 1602 m. 1955.

5. **F. brachyneuron** Broth. & Fl.
Manalur at 1067 m. 1926.

*6. **F. ceylonensis** Doz. & Molk. var. **acutifolius** Dix. & Varde in *Rev. Bryol.* 52 : 38, 1925.

7. **F. crispo-circinans** Card.
Shembaganur at 1980 m. 1909.

8. **F. cristatus** Wils.
Kodaikanal at 2133 m. 1927.

9. **F. curgensis** Broth.
Tiger Shola at 1676 m. 1923.

*10. **F. curvatoxiphioides** Dix. & Varde in *Arch. Bot.* 1 : 163, 1927.
Tiger Shola at 1676 m. 1927 ; Manalur at 1067 m. 1926.

11. **F. excedens** Broth.
Shembaganur at 1866 m. 1959 ; Old Ghat Road at 1676 m. 1959.

12. **F. karwarensis** Dix.
Old Ghat Road at 1676 m. 1929.

*13. **F. microdictyon** Dix. & Varde in *Arch. Bot.* 1 : 163, 1927.
Tiger Shola at 1706 m. 1926.

14. **F. minutus** Thw. & Mitt.
Shembaganur at 1866 m. 1926.

15. **F. nymannii** (Fl.) Par.
Perumalmalai at 1562 m. 1956.

16. **F. pennatulus** Thw. & Mitt.
Shembaganur at 1866 m. 1926 ; Perumalmalai at 1699 m. 1926.

*17. **F. perumalensis** Dix. & Varde in *Arch. Bot.* 1 : 163, 1927.
Itti Pallam, near Perumalmalai, at 1699 m. 1927.

18. **F. schmidii** C.M.
Shembaganur at 1866 m. 1949 ; Perumalmalai at 1600 m. 1959.

19. **F. sylvaticus** Griff.
Shembaganur at 1828 m. 1909.

20. **F. walkeri** Broth.
Manalur at 1067 m. 1926.

21. **F. walkeri** Broth. var. **elimbatus** (Broth.) Dix.
Bottom Station at 900 m. 1929.

II. ARCHIDIACEAE

Archidium Brid.

(Derived from the Greek *archidion* = primitive)

*22. **A. microthecium** Dix. & Varde in *Ann. Crypt. Exot.* 1 : 37, 1928.
Kodaikanal at 2133 m. 1922.

III. DITRICHACEAE

Ceratodon Brid.

(Derived from the Greek *keras* = a horn, and *odous* = a tooth, with reference to the peristome teeth which resemble a goat's horn)

23. **C. purpureus** (Lind.) Brid.
Shembaganur, Eucalyptus Forest, at 1798 m. 1959; Berijam, in sholas, at 2286 m. 1959.

24. **C. purpureus** (Lind.) Brid. var. **xantopus** Sull.
Perumalmalai at 1602 m. 1927.

Ditrichum Timm.

(Derived from the Greek *di* = two, *tricho* = hair, with reference to the filiform peristome teeth)

25. **D. amoenum** (Thw. & Mitt.) Par.
Shembaganur, Eucalyptus Forest, at 1798 m. 1959; Shembaganur at 1844 m. 1959.

26. **D. flexifolium** (Hook.) Hampe
Tiger Shola at 1813 m. 1926.

27. **D. tortipes** (Mitt.) Par.
Shembaganur at 1844 m. 1927.

*28. **D. tortipes** (Mitt.) Par. var. **strictum** Dix. & Varde in *Arch. Bot.* 1: 177, 1927.
Shembaganur, Old Ghat Road, at 1737 m. 1927.

Pleuridium Brid.

(Derived from the Greek *pleuridion* = on one side, with reference to the capsules at times being lateral)

29. **P. denticulatum** (C.M.) Mitt.
Perumalmalai Peak at 2194 m. 1926; Perumalmalai Slopes at 1981 m. 1958; Old Ghat Road at 763 m. 1959.

IV. DICRANACEAE

BROTHERA C.M.

(After Brotherus, Viktor Ferdinand [1848-1929], a German botanist)

30. **B. leana** (Sull.) C.M.
Perumalmalai Shola at 1676 m. 1926.

CAMPYLOPODIUM C.M.

(Derived from the Greek *kampylo* = bent, *podion* = a small foot, with reference to the bent seta of the capsule)

31. **C. khasianum** (Griff.) Par.
Tiger Shola at 1676 m. 1927.

CAMPYLOPUS Brid.

(Derived from the Greek *kampylo* = bent, *pous* = a foot, with reference to the bent seta of the capsule)

*32. **C. andreanus** Card. & Varde in *Rev. Bryol.* 49 : 37, 1922.
Shembaganur at 1798 m. 1959 ; Kodaikanal at 2003 m. 1959.

33. **C. comosus** (R. & Hsch.) V.D.B. & Lac.
Tiger Shola at 1676 m. 1927.

34. **C. eberhardti** Par.
Kodaikanal at 2133 m. 1921.

35. **C. erythrognaphalus** (C.M.) Jaeg.
Shembaganur at 1844 m. 1959 ; Kodaikanal at 2164 m. 1959.

36. **C. flagelliferus** (C.M.) Jaeg.
Kodaikanal at 2103 m. 1959; Kodaikanal, on bark of *Rhododendron*, at 2286 m. 1959.

37. **C. goughii** (Mitt.) Broth.
Tiger Shola at 1828 m. 1926.

38. **C. introflexus** (Hedw.) Mitt.
Top Station at 1844 m. 1929.

39. **C. laetus** (Mitt.) Jaeg.
Shembaganur at 1828 m. 1911.

*40. **C. laetus** (Mitt.) Jaeg. var. **madurensis** Thér. & Varde in *Rev. Bryol.* 52 : 38, 1925.
Kodaikanal at 2103 m. 1912.

41. **C. nilgiriensis** (Mitt.) Jaeg.
Perumalmalai at 1676 m. 1927 ; Berijam Road at 2286 m. 1959.

42. **C. nodiflorus** (C.M.) Jaeg.
Shembaganur at 1798 m. 1959 ; Kodaikanal at 2003 m. 1959.

43. **C. polytrichoides** de Not.
Kodaikanal at 2400 m. 1921.

44. **C. reconditus** Thw. & Mitt.
Kodaikanal, Levinge Path, at 1981 m. 1959 ; Tiger Shola at 1676 m. 1926.

*45. **C. roinei** Card. & Varde in *Rev. Bryol.* 49 : 37, 1922.
Tiger Shola at 1828 m. 1926.

46. **C. reduncus** (R. & Hsch.) V.D.B. & Lac.
Perumalmalai at 1600 m. 1923.

47. **C. subfragilis** Ren. & Card.
Shembaganur at 1798 m. 1959.

DICRANELLA W.P. Sch.

(Derived from the diminutive of the Greek *dicranon* = a two-pronged fork, with reference to the shape of the peristome teeth)

*48. **D. denticulata** Card. & Varde in *Rev. Bryol.* 49 : 34, 1922.
Kodaikanal at 2103 m. 1909.

49. **D. divaricata** (Mitt.) Jaeg.
Kodaikanal at 2194 m. 1911.

50. **D. madurensis** Card.
Kodaikanal at 1980 m. 1909.

*51. **D. stricticaulis** Card. & Varde in *Rev. Bryol.* 49 : 35, 1922.
Shembaganur at 1828 m. 1911.

DICRANODONTIUM (?)

(Derived from the Greek *dicranon* = a two-pronged fork, *odous* = a tooth, with reference to the shape of the peristome teeth)

*52. **D. perviride** Dix. & Varde in *Rev. Bryol.* 52 : 38, 1925.
Kodaikanal at 2057 m. 1959.

DICRANOLOMA Ren.

(Derived from the Greek *dicranon* = a two-pronged fork, *loma* = border, with reference to the shape of the peristome teeth)

†53. **D. fragile** (Hook.) Broth.
Shembaganur at 1859 m. 1959 ; Tiger Shola at 1676 m. 1959.

DICRANUM Hedw.

(Derived from the Greek *dicranon* = a two-pronged fork, with reference to the shape of the peristome teeth)

*54. **D. dilatinerve** Card. & Varde in *Rev. Bryol.* 49 : 35, 1922.
Kodaikanal at 2164 m. 1909.

HOLOMITRIUM Brid.

(Derived from the Greek *holos* = entire, *mitrion* = a cap, with reference to the calyptra)

55. **H. griffithianum** Mitt.
Perumalmalai at 1600 m. 1926 ; Kodaikana at 2170 m. 1929.

LEUCOLOMA Brid.

(Derived from the Greek *leuco* = white, *loma* = fringe, with reference to the peristome)

56. **L. molle** (C.M.) Mitt.
Kodaikanal at 2286 m. 1926.

57. **L. nitens** (Thw. & Mitt.) Jaeg.
Perumalmalai Shola at 1768 m. 1926.

MICROCAMPYLOPUS C.M.

(Derived from the Greek *micro*=small, *campylo*=bent, and *pous*=a foot, with reference to the small and bent seta of the capsule)

58. **M. subnanus** (C.M.) Broth.
Shembaganur at 1981 m. 1959.

THYSANOMITRIUM Sch.

(Derived from the Greek *thusanos* = fringe, *mitrion* = a cap, with reference to the calyptra)

*59. **T. depallieri** Card. & Varde in *Rev. Bryol.* 49 : 38, 1922.
Kodaikanal at 2003 m. 1912 ; Tiger Shola at 1676 m. 1929.

*60. **T. foreauanum** Card. & Varde in *Rev. Bryol.* 49 : 38, 1922.
Kodaikanal at 2400 m. 1912.

*61. **T. leioneuron** Thér. & Varde in *Rev. Bryol.* 49 : 40, 1922.
Kodaikanal at 2133 m. 1927.

62. **T. nigrescens** (Mitt.) Broth.
Kodaikanal, Levinge Path, at 2050 m. 1959.

63. **T. umbellatum** W. et Arn.
Tiger Shola at 1676 m. 1959 ; Tovaiparai at 1371 m. 1959.

TREMATODON Rich.

(Derived from the Greek *tremato* = perforated, *odous* = a tooth, with reference to the peristome teeth)

64. **T. ceylonensis** C.M.
Perumalmalai, near Neutral Saddle, at 1600 m. 1959 ; Shembaganur, Levinge Path, at 1905 m. 1959.

65. **T. schmidii C.M.**
Perumalmalai at 1554 m. 1926.

WILSONIELLA C.M.

(After Wilson)

66. **W. pellucida** (Wils.) C.M.
Palamalai at 1066 m. 1925.

V. LEUCOBRYACEAE

LEUCOBRYUM Hampe

(Derived from the Greek *leuco* = white, *bryon* = a moss, with reference to the colour of the plant)

67. **L. angustifolia** Wils.
Shembaganur at 1844 m. 1911.

68. **L. bowringii** Mitt.
Shembaganur at 1813 m. 1911.

69. **L. humillimum** Card.
Manalur at 914 m. 1926.

70. **L. neilgherense** C.M.
Tiger Shola at 1885 m. 1912; Shembaganur, Old Ghat Road, at 1870 m. 1959.

71. **L. scalare** C.M.
Shembaganur, Old Ghat Road, at 1748 m. 1959.

72. **L. wichurae** Broth.
Kodaikanal at 2133 m. 1911.

OCTOBLEPHARUM Hedw.

(Derived from the Greek *octo* = eight, *blepharon* = cilia, with reference to the cilia of the inner peristome)

73. **O. albidum** (Lind.) Hedw.
Machur at 1371 m. 1959 ; Kodaikanal at 2150 m. 1953.

VI. CALYMPERACEAE

CALYMPEROPSIS C.M.

(Derivation uncertain)

74. **C. semiliber** (Mitt.) Fl.
Shembaganur at 1844 m. 1929.

SYRRHOPODON Sch.

(Derived from the Greek *surrhos* = jointed, *podous* = a foot, with reference to the foot of the capsule)

*75. **S. calymperoides** Card. & Varde in *Rev. Bryol.* 49 : 42, 1922.
Kodaikanal at 2300 m. 1909.

*76. **S. leucophanoides** Card. & Varde in *Rev. Bryol.* 49 : 42, 1922.
Kodaikanal at 2200 m. 1909 ; Perumalmalai Shola at 1554 m. 1956.

77. **S. strictus** Thw. & Mitt.
Shembaganur at 1865 m. 1956.

VII. POTTIACEAE

ANOECTANGIUM Hedw.

(Derived from the Greek *anoik* = to open, *angion* = a vessel, with reference to the wide-mouthed capsule)

78. **A. euchloron** (Sch.) Mitt.
Machur, along Law's Ghat Road, at 1371 m. 1959; Parappar, along Law's Ghat Road, at 1785 m. 1959.

79. **A. stracheyanum** Mitt.
Law's Ghat Road at 363 m. 1959; Kodaikanal, Levinge Path, at 2057 m. 1959.

ASTOMUM Hampe

(Derived from the Greek *a* = without, *stoma* = a mouth, with reference to the small mouth of the capsule)

80. **A. edentulum** (Mitt.) Fl.
Tiger Shola at 1676 m. 1922; Manalur at 1067 m. 1926.

*81. **A. minutum** Dix. & Varde in *Arch. Bot.* 1 : 165, 1927.
Tiger Shola at 1676 m. 1927; Palamalai at 914 m. 1925.

BARBULA Hedw.

(Derived from the Latin *barbula* = a small beard, with reference to the peristome)

*82. **B. denticulata** Dix. & Varde in *Arch. Bot.* 1 : 167, 1927.
Law's Ghat Road at 750 m. 1959; Tiger Shola at 1676 m. 1926.

83. **B. dharwarensis** Dix.
Villupatti at 1371 m. 1926.

84. **B. indica** Brid.
Law's Ghat Road at 755 m., 1737 m. 1959; Manalur at 914 m. 1929.

DIDYMODON Hedw.

(Derived from the Greek *didumos* = double, *odous* = a tooth, with reference to the peristome teeth)

*85. **D. obtusifolius** Card. in *Arch. Bot.* 1 : 167, 1927.
Perumalmalai at 1600 m. 1926; Shembaganur at 1844 m. 1929; Kodaikanal at 2170 m. 1929.

86. **D. rigidulus** Hedw.
Perumalmalai at 1600 m. 1927; Kodaikanal at 2170 m. 1927.

87. **D. rufescens** (Hook.) Broth.
Perumalmalai at 1676 m. 1930.

*88. **D. strictifolius** Dix. & Varde in *Arch. Bot.* 1 : 167, 1927.
Perumalmalai at 1600 m. 1927; Kodaikanal at 2270 m. 1927, 1959.

HYMENOSTOMUM R.Br.

(Derived from the Greek *hymen* = a thin membrane, *stoma* = a mouth, with reference to the mouth of the capsule)

89. **H. edentulum** (Mitt.) Besch.
Tiger Shola at 1844 m. 1925.

HYMENOSTYLIUM Brid.

(Derived from the Greek *hymen* = a thin membrane, *stylion* = a column, with reference to the capsule)

*90. **H. validinerve** Dix. & Varde in *Ann. Crypt. Exot.* 3 (4) : 174, 1930.
Top Station at 1844 m. 1929.

HYOPHILA Brid.

(Derived from the Greek *hyo* = rain, *philos* = loving, with reference to the habitat of the plant)

*91. **H. comosa** Dix. & Varde in *Arch. Bot.* 1 : 166, 1927 ; *Ann. Crypt. Exot.* 3 (4) : 186, 1930.
Shembaganur at 1828 m. 1927 ; Manalur at 1066 m. 1926.

92. **H. involuta** (Hook.) Jaeg.
Law's Ghat Road at 1676 m. 1959 ; Kodaikanal, Levinge Path, at 1981 m. 1959.

*93. **H. mollifolia** Dix. & Varde in *Arch. Bot.* 1 : 167, 1927.
Law's Ghat Road, at 1602 m. 1927 ; 662 m. 1959 ; Tovaiparai at 1371 m. 1959.

*94. **H. validinervis** Card. & Varde in *Rev. Bryol.* 49 : 43, 1922.
Kodaikanal, Pambar Ravine, at 2400 m. 1912 ; Tiger Shola at 1676 m. 1913 ; Law's Ghat Road at 758 m. 1959.

*95. **H. viridula** Card. & Varde in *Rev. Bryol.* 49 : 44, 1922.
Kodaikanal, Pambar Ravine, at 2300 m. 1912.

MERCEYOPSIS (?)

(Derivation uncertain)

96. **M. stenophylla** Card.
Law's Ghat Road at 1000 m. 1912.

POTTIA Ehrh.

(After Pott, a bryologist of Brunswick)

*97. **P. denticulata** Dix. & Varde in *Arch. Bot.* 1 : 168, 1927.
Perumalmalai Shola at 1676 m. 1926 ; Law's Ghat Road at 1600 m. 1959.

PSEUDOSYMBLEPHARIS (?)

(Derived from the Greek *pseudo* = false, *symblepharis* = a ciliated moss)

*98. **P. indica** Dix. & Varde in *Arch. Bot.* 1 : 166, 1927.
Tiger Shola at 1820 m. 1926 ; Shembaganur at 1844 m. 1959.

RHAMPHIDIUM Mitt.

(Derived from the Greek *rhamphos* = a beak, with reference to the shape of the capsule)

*99. **R. madurense** Dix. & Varde in *Arch. Bot.* 1 : 165, 1927.
Tiger Shola at 1737 m. 1926, 1959.

TIMMIELLA de Not.

(After Timm, a botanist of Mecklenburg)

100. **T. anomala** (B.E.) Limp.
Tiger Shola at 1710 m. 1959.

TORTULA C.M.

(Derived from the Latin *tortus* = twisted, with reference to the appearance of the peristome)

101. **T. schmidii** (C.M.) Broth.
Top Station at 1828 m. 1929.

TRICHOSTOMUM Hedw.

(Derived from Greek *tricho* = a hair, *stoma* = a mouth, with reference to the mouth of the capsule)

102. **T. cylindricum** (Bruch.) C.M.
Shembaganur at 1828 m. 1927, 1959.

103. **T. duriusculum** (Mitt.) Broth.
Tiger Shola at 1710 m. 1927 ; Perumalmalai at 1600 m. 1957.

104. **T. hyalinoblastum** Broth.
Periyur at 1371 m. 1926 ; Shembaganur at 1830 m. 1926.

*105. **T. minusculum** Dix. & Varde in *Arch. Bot.* 1 : 165, 1927.
Perumalmalai Shola at 1676 m. 1926 ; Top Station at 1844 m. 1926.

106. **T. orthodontum** (Mitt.) Broth.
Kodaikanal at 1828 m. 1926 ; Periyur at 1371 m. 1926.

107. **T. stenophyllum** (Mitt.) Broth.
Tiger Shola at 1676 m. 1959.

WEISIA Hedw.

(After Weis, an 18th century botanist of Gottingen)

*108 **W. macrospora** Card. & Varde in *Rev. Bryol.* 49 : 43, 1922.
Shembaganur at 2000 m. 1910 ; Law's Ghat Road at 762 m. 1959 ; at 1970 m. 1959.

109. **W. viridula** (Lind.) Hedw.
Manalur at 914 m. 1926 ; Top Station at 1828 m. 1959.

VIII. GRIMMIACEAE

GRIMMIA Ehrh.

(After Grimm, an 18th century botanist of Gotha)

110. **G. ovata** Weber & Mohr.
Kodaikanal, Pambar Shola, at 2003 m. 1951.

RHACOMITRIUM Brid.

(Derived from the Greek *rhako* = frayed, *mitrion* = a cap, with reference to the fringed calyptra of the capsule)

*111. **R. javanicum** Doz. & Molk. var. **brachyphyllum** Card. & Varde in *Rev. Bryol.* 50 : 17, 1923.
Kodaikanal at 1905 m. 1911.

IX. FUNARIACEAE

FUNARIA Sch.

(Derived from the Latin *funis* = a cord, with reference to the seta spirally twisted when dry)

*112. **F. excurrentinervis** Card. & Varde in *Rev. Bryol.* 50 : 18, 1923.
Locality unspecified.

113. **F. hygrometrica** (Lind.) Sibt.
Kodaikanal, Mount St. Mary, at 2133 m. 1959.

114. **F. hygrometrica** (Lind.) Sibt. var. **calvescens** B. & S.
Shembaganur at 1830 m. 1909.

115. **F. physcomitrioides** Mont.
Kodaikanal at 2469 m. 1911.

116. **F. planifolia** (Thw. & Mitt.) Broth.
Berijam at 2133 m. 1923.

*117. **F. pulchra** Dix. & Varde in *Arch. Bot.* 1 : 169, 1927.
Manalur at 914 m. 1926 ; Villupatti at 1371 m. 1926.

*118. **F. sinuatolimbata** Card. & Varde in *Rev. Bryol.* 50 : 19, 1923.
Kodaikanal at 2133 m. 1909 ; Perumalmalai Shola at 1981 m. 1926.

*119. **F. subimmarginata** Card. & Varde in *Rev. Bryol.* 50 : 19, 1923.
Shembaganur at 1828 m. 1909.

120. **F. submarginata** (C.M.) Broth.
Perumalmalai Shola at 1676 m. 1927.

X. SPLACHNACEAE

TAYLORIA Hook.

(After Taylor, Thomas [d. 1848], the joint author, with W. J. Hooker, of *Muscologia Britannica*)

121. **T. imbricata** Thw. & Mitt.
Shembaganur at 1844 m. 1930.

XI. BRYACEAE

ANOMOBRYUM W.P. Sch.

(Derived from the Greek *a* = not, *nomos* = rule, meaning a 'nonconformist' Bryum)

122. **A. cymbifolium** (Lindl.) Broth.
Perumalmalai at 1706 m. 1928.

123. **A. filiforme** (Dick.) Husn.
Tiger Shola at 1676 m. 1926.

*124. **A. latifolium** Card. & Varde in *Rev. Bryol.* 50 : 19, 1923 ; *Arch. Bot.* 1 : 179, 1927.
Silver Cascade at 1800 m. 1911 ; Tiger Shola at 1721 m. 1959.

*125. **A. subnitidum** Card. & Varde in *Rev. Bryol.* 50 : 20, 1923 ; *Arch. Bot.* 1 : 179, 1927.
Shembaganur at 1900 m. 1912, 1959 ; Law's Ghat Road at 1752 m. 1959.

BRACHYMENIUM Hook.

(Derived from the Greek *brachus* = close-celled, *menium* = tissue, probably with reference to the anatomy of the plant)

†126. **B. exile** Doz. & Molk.
Law's Ghat Road at 685 m. 1959 ; Tovaiparai at 1371 m. 1959 ; Perumalmalai at 1602 m. 1959 ; Levinge Path at 1981 m. 1959.

†127. **B. leptostomoides** (C.M.) Schim.
Shembaganur at 1828 m. 1926 ; Perumalmalai at 1562 m. 1959 ; Tovaiparai at 1371 m. 1959.

128. **B. nepalense** Hook.
Perumalmalai at 1615 m. 1937.

BRYUM Dill.

(Derived from the Greek *bryon*, the name of a cryptogamic plant)

129. **B. ambiguum** Dub.
Law's Ghat Road at 1545 m. 1925.

*130. **B. andrei** Card. & Varde in *Rev. Bryol.* 50 : 20, 1923 ; *Arch. Bot.* 1 : 179, 1927.
Kodaikanal at 2133 m. 1909 ; Shembaganur at 1828 m. 1927.

131. **B. apalodictyoides** C.M.
Tiger Shola at 1676 m. 1927.

132. **B. argenteum** Lind.
Law's Ghat Road at 685 m. 1959 ; Tovaiparai at 1371 m. 1959 ; Perumalmalai at 1602 m. 1959 ; Kodaikanal at 2133 m. 1959.

133. **B. argenteum** Lind. var. **lanatum** (P.B.) C.M. & W.P. Sch.
Shembaganur at 1828 m. 1927.

134. **B. nitens** Hook.
Manalur at 1067 m. 1927 ; Machur at 1550 m. 1927.

*135. **B. pachycladum** Card. in *Rev. Bryol.* 52 : 38, 1925 ; *Arch. Bot.* 1 : 179, 1927. Munjikal at 1980 m.1912 ; Levinge Path at 1980 m. 1959.

136. **B. pseudoalpinum** Ren. & Card. Shembaganur at 1860 m. 1950 ; Law's Ghat Road at 1737 m. 1959.

†137. **B. ramosum** (Hook.) Mitt. Shembaganur at 1905 m. 1959 ; Tiger Shola at 1737 m. 1959.

*138. **B. retusifolium** Card. & Varde in *Rev. Bryol.* 50 : 20, 1923. Kodaikanal at 2400 m. 1911 ; Kodaikanal at 2120 m. 1959 ; Perumalmalai at 1737 m. 1926.

*139. **B. retusifolium** Card. & Varde var. **heterophyllum** Card. Shembaganur at 1830 m. 1911.

*140. **B. vellei** Card. & Varde in *Rev. Bryol.* 50 : 21, 1923 ; *Arch. Bot.* 1 : 179, 1927. Shembaganur at 2000 m. 1909 ; Kodaikanal at 2133 m. 1912 ; Law's Ghat Road at 1750 m. 1959.

*141. **B. vellei** Card. & Varde var. **robustum** Dix. & Varde in *Arch. Bot.* 1 : 179, 1927. Tiger Shola at 1706 m. 1926.

142. **B. wightii** Mitt. Perumalmalai at 1540 m. 1926.

RHODOBRYUM W.P. Sch.

(Derived from the Greek *rhodos* = a rose, *bryon* = a moss, probably with reference to the habit of the plant)

143. **R. giganteum** (Hook.) Par. Tiger Shola at 1667 m. 1953.

*144. **R. madurense** Dix. & Varde in *Ann. Crypt. Exot.* 3 (4) : 177, 1930. Kodaikanal at 1981 m. 1919, 1929 ; Berijam at 2133 m. 1929.

WEBERA Hedw.

(After Weber, an 18th century botanist of Gottingen)

145. **W. elongata** Sch. Kodaikanal, Levinge Path, at 1981 m. 1930 ; Tiger Shola at 1676 m. 1930.

146. **W. flexuosa** (Hook.) Mitt. Kodaikanal at 2133 m. 1926 ; Tiger Shola at 1676 m. 1926 ; Shembaganur at 1840 m. 1959.

*147. **W. humicola** Dix. & Varde in *Arch. Bot.* 1 : 169, 1927. Palamalai at 914 m. 1925.

XII. MNIACEAE

MNIUM W.P. Sch.

(Derived from the Greek *mnion* = a moss)

148. **M. coriaceum** Griff. Old Ghat Road at 1737 m. 1959.

149. **M. incertum** Dix.
Tiger Shola at 1676 m. 1927.

150. **M. rostratum** Schr.
Berijam at 2133 m. 1929.

151. **M. succulentum** Mitt.
Shembaganur at 1828 m. 1912 ; Kodaikanal at 2286 m. 1959.

XIII. RHIZOGONIACEAE

RHIZOGONIUM Brid.

(Derived from the Greek *rhiza* = a root, *gonia* = an angle, probably with reference to the root of the plant)

†152. **R. spiniforme** (Lind.) Bruch.
Old Ghat Road at 1746 m. 1959 ; Law's Ghat Road at 2057 m. 1959.

XIV. BARTRAMIACEAE

BARTRAMIA Hedw.

(After Bartram, John [1699-1777], an English botanist in America)

*153. **B. gathica** Card. & Varde in *Rev. Bryol.* 50 : 22, 1923 ; 51 : 12, 1924 ; *Arch. Bot.* 1 : 180, 1927.
Kodaikanal, Pambar torrent, at 2133 m. 1909, 1927.

*154. **B. madurensis** Card. & Varde in *Rev. Bryol.* 52 : 39. 1925 ; *Arch. Bot.* 1 : 180, 1927.
Kodaikanal at 2103 m. 1959.

BARTRAMIDULA B.E.

(Derivation similar to that of *Bartramia*)

*155. **B. dispersa** Dix. & Varde in *Rev. Bryol.* 50 : 23, 1923 ; ibid. 52 : 42, 1925.
Kodaikanal, Pambar Ravine, at 2400 m. 1912 ; Tiger Shola at 1676 m. 1923 ; Shembaganur, Levinge Path, at 1981 m. 1959.

BREUTELIA W.P. Sch.

(After Breutel, a German botanist)

*156. **B. sclerodictya** Card. & Varde in *Rev. Bryol.* 50 : 24, 1923 ; 51 : 12, 1924 ; *Arch. Bot.* 1 : 180, 1927.
Kodaikanal at 2133 m. 1911 ; Shembaganur at 1828 m. 1911, 1959 ; Perumalmalai at 1602 m. 1926.

PHILONOTIS Brid.

(Derived from the Greek *philo* = loving, *notis* = moisture, with reference to the characteristic habitat of the plant)

157. **P. alpicola** Jurat.
Kodaikanal at 2133 m. 1929.

*158. **P. anisoclada** Card. & Varde in *Rev. Bryol.* 50 : 23, 1923 ; *Arch. Bot.* 1 : 180, 1927.
Kodaikanal at 2133 m. 1908 ; Law's Ghat Road at 1720 m. 1959.

159. **P. falcata** (Hook.) Mitt.
Kodaikanal at 2133 m. 1958.

160. **P. heterophylla** Mitt.
Kodaikanal at 2133 m. 1925 ; Perumalmalai at 1602 m. 1959.

161. **P. imbricatula** Mitt.
Law's Ghat Road at 1676 m. 1959.

162. **P. laxissima** C.M.
Tiger Shola at 1676 m. 1926.

163. **P. rigida** Brid.
Kodaikanal at 1980 m. 1922.

164. **P. secunda** Doz. & Molk.
Old Ghat Road at 1676 m. 1959.

*165. **P. subrigida** Card. & Varde in *Rev. Bryol.* 50 : 22, 1923 ; *Arch. Bot.* 1 : 180, 1927.
Kodaikanal at 2133 m. 1909 ; Tiger Shola at 1600 m. 1926 ; Law's Ghat Road at 680 m. 1959 ; Tovaiparai at 1371 m. 1959.

166. **P. tomentella** Mol.
Perumalmalai at 1768 m. 1911.

XV. ORTHOTRICHACEAE

MACROMITRIUM Brid.

(Derived from the Greek *macro* = large, *mitrion* = a cap, with reference to the size of the calyptra)

167. **M. calympereoideum** Mitt.
Perumalmalai at 1602 m. 1926.

168. **M. japonicum** Doz. & Molk.
Locality unspecified.

*169. **M. lingulatum** Card. & Varde in *Rev. Bryol.* 50 : 18, 1923.
Kodaikanal at 2133 m. 1909.

170. **M. nepalense** (Hook. & Gev.) Schw.
Perumalmalai at 1602 m. 1959 ; Shembaganur at 1844 m. 1959.

171. **M. perrottetii** C.M.
Shembaganur at 1828 m. 1926.

172. **M. schmidii** C.M.
Shembaganur at 1828 m. 1929.

*173. **M. schmidii** C.M. var. **laxirete** Thér. & Varde in *Rev. Bryol.* 52 : 39, 1925.
Kodaikanal at 2100 m. 1926.

RHACHITHECIUM (?)

(Derived from the Greek *rhachis* = a spine, *thekion* = a capsule, with reference to the shape of the capsule)

174. **R. perpusillum** (Thw. & Mitt.) Broth.
Perumalmalai, Neutral Saddle, at 1602 m. 1959.

SCHLOTHEIMIA Brid.

(After Schlotheim)

175. **S. grevilleana** Mitt.
Perumalmalai at 1602 m. 1959.

TRIGONODICTYON Dix. & Varde

(Derived from the Greek *trigonos* = triangular, *dictyon* = a network, with reference to the tissue of the plant)

*176. **T. indicum** Dix. & Varde in *Ann. Crypt. Exot.* 1 : 40, 1928.
Kodaikanal, Pambar Torrent, at 2057 m. 1927.

ZYGODON Hook & Tayl.

(Derived from the Greek *zugo* = united, *odous* = a tooth, with reference to the peristome teeth being joined in pairs)

177. **Z. erosus** Mitt. var. **fragilifolius** (Broth.) Dix.
Kodaikanal, towards Berijam, at 2194 m. 1959.

178. **Z. humilis** Thw. & Mitt.
Old Ghat Road, in the Shola, at 1798 m. 1930.

179. **Z. reinwardtii** (Hsch.) A. Braun
Kodaikanal, Upper Lake Road, at 2133 m. 1929.

180. **Z. tetragonostomus** R. Br.
Manalur at 914 m. 1923 ; Perumalmalai at 1602 m. 1959 ; Shembaganur at 1828 m. 1929 ; Kodaikanal at 2190 m. 1959.

XVI. RHACOPILACEAE

RHACOPILUM P.B.

(Derivation uncertain)

181. **R. orthocarpum** Wils.
Kodaikanal at 2133 m. 1912.

182. **R. schmidii** C.M.
Tovaiparai at 1371 m. 1958 ; Law's Ghat Road at 1602 m. 1959.

*183. **R. schmidii** C.M. var. **breviaristatum** Card. in *Rev. Bryol.* 50 : 77, 1923.
Tiger Shola at 1676 m. 1912.

XVII. HEDWIGIACEAE

BRAUNIA B.E.

(After Braun, A. [1805-1877], a German botanist)

184. **B. apiculata** Card.
Kodaikanal at 2286 m. 1909.

185. **B. macrocarpa** (C.M.) Jaeg.
Kodaikanal at 2133 m. 1926.

† 186. **B. secunda** Hook.
Kodaikanal at 2140 m. 1926.

HEDWIGIUM B.E.

(After Hedwig, Johannes [1730-1799], the ' father of Bryology ')

187. **H. imberbe** Sm.
Kodaikanal at 2133 m. 1926.

XVIII. CRYPHAEACEAE

ACROCRYPHAEA B.E.

(Derived from the Greek *acro* = top, *kryphaios* = hidden, with reference to the capsule)

188. **A. concavifolia** (Griff.) V.D.B. & Lac.
Perumalmalai, near Neutral Saddle, at 1737 m. 1926.

FORSSTROEMIA Lind.

(After Forsstroem)

189. **F. indica** (Mont.) Par.
Manalur at 914 m. 1926; Tovaiparai at 1371 m. 1926; Tiger Shola at 1676 m. 1926.

XIX. TRACHYPODACEAE

TRACHYPUS Rein. & Hsch.

(Derived from the Greek *trachys* = rough, *pous* = a foot, probably with reference to the foot of the capsule)

190. **T. bicolor** R. & H. var. **hispidus** (C.M.) Card.
Kodaikanal at 2140 m. 1959.

191. **T. humilis** Lind. var. **humilis**
Tiger Shola at 1450 m. 1926.

192. **T. humilis** Lind. var. **tenerrimus** (Herz.) Zant.
Tovaiparai Shola at 1450 m. 1926.

TRACHYPODOPSIS Fl.

(Derivation same as in the case of *Trachypus*)

193. **T. serrulata** (P. Beauv.) Fl. var. **crispatula** (Hook.) Zant.
Old Ghat Road at 1780 m. 1959.

XX. MYURIACEAE

MYURIUM W.P. Sch.

(Derived from the Greek *myouros* = mouse-tailed, with reference to the julaceous branches of the plant)

194. **M. rufescens** (Rein. & Hsch.) Fl.
Shembaganur at 1830 m. 1927.

195. **M. warburgii** (C.M.) Fl.
Perumalmalai at 1600 m. 1929.

*196. **M. warburgii** (C.M.) Fl. var. **stenophyllum** Card. in *Rev. Bryol.* 50 : 72, 1923 as *Oedicladium warburgii* C.M. var. *stenophyllum* Card. & Varde.
Kodaikanal at 2140 m. 1912 ; Tiger Shola at 1706 m. 1959.

XXI. PTEROBRYACEAE

JAEGERINA Mull.

(After Jaeger, August [d. 1877], a German botanist)

*197. **J. stolonifera** C.M. var. **incrassata** Varde in *Rev. Bryol.* 52 : 39, 1925.
Perumalmalai at 1602 m. 1926.

PTEROBRYOPSIS

(Derived from the Greek *pteron* = wing, *bryon* = a moss, probably with reference to the spreading habit of the plant)

198. **P. acuminata** (Hook.) Fl.
Locality unspecified.

*199. **P. denudata** Dix. & Varde in *Rev. Bryol.* 50 : 72, 1923.
Kodaikanal, on trees, at 2400 m. 1912.

200. **P. frondosa** (Mitt.) Jaeg.
Perumalmalai at 1600 m. 1926.

*201. **P. madurensis** Card. & Varde in *Rev. Bryol.* 50 : 72, 1923.
Kodaikanal at 2130 m. 1911 ; Manalur at 860 m. 1926.

*202. **P. madurensis** Card. & Varde var. **flexipendula** Card. & Varde in *Rev. Bryol.* 50 : 73, 1923.
Kodaikanal, Pillar Rocks, at 2400 m. 1912 ; Tiger Shola at 1737 m. 1912.

203. **P. orientalis** (C.M.) Fl.
Tovaiparai Shola at 1554 m. 1926.

204. **P. orientalis** (C.M.) Fl. var. **gracilis** (Broth.) Dix.
Periyur at 1371 m. 1929.

205. **P. schmidii** (C.M.) Fl.
Kodaikanal at 2057 m. 1926.

SYMPHYSODONTELLA (?)

(Derived from the Greek *syn* = together, *phu* = to grow, *odontella* = small teeth, probably with reference to the growth-habit of the plant)

206. **S. involuta** (Thw. & Mitt.) Fl.
Perumalmalai at 1602 m. 1926.

XXII. METEORIACEAE

AEROBRYIDIUM (?)

(Derived from the Greek *aeiros* = high in air, *bryidium* = moss-like, with reference to the pendent habit of the plant)

207. **A. punctulatum** (C.M.) Dix.
Kodaikanal at 2190 m. 1959 ; Perumalmalai at 1600 m. 1959 ; Tovaiparai at 1370 m. 1959.

AEROBRYOPSIS (?)

(Derivation similar to that of *Aerobryidium*)

208. **A. lanosa** (Mitt.) Fl.
Kodaikanal at 2130 m. 1909.

209. **A. longissima** (Doz. & Molk.) Fl.
Kodaikanal at 2100 m. 1959 ; Tovaiparai Shola at 1371 m. 1959.

BARBELLA C.M.

(Derived from the Latin *barbella,* meaning a small beard, with reference to the habit of the plant)

210. **B. determesii** (Ren. & Card.) Fl.
Tiger Shola at 1750 m. 1959 ; Shembaganur at 1798 m. 1959.

211. **B. enervis** (Mitt.) Fl.
Perumalmalai Shola at 1540 m. 1926.

212. **B. pendula** (Sull.) Fl.
Tiger Shola at 1602 m. 1911.

*213. **B. questi** Card. & Dix. in *Rec. Bot. Surv. India* 6. (3) : 82, 1914.
Shembaganur at 1828 m. 1911.

214. **B. tenax** (C.M.) Broth.
Law's Ghat Road at 1798 m. 1959.

CHRYSOCLADIUM (?)

(Derived from the Greek *chryso* = golden, *kladion* = a shoot, probably with reference to the colour of the tender shoot of the plant)

215. **C. retrorsum** (Mitt.) Fl.
Shembaganur at 1830 m. 1959.

FLORIBUNDARIA C.M.

(Derived from the Latin *floribundus* = much flowering, probably with reference to the profusely branching habit of the plant)

216. **F. chloronema** (C.M.) Fl.
Kodaikanal at 2190 m. 1959.

217. **F. floribunda** (Doz. & Molk.) Fl.
Shembaganur at 1830 m. 1959 ; Tovaiparai at 1370 m. 1959.

218. **F. sparsa** (Mitt.) Broth.
Kodaikanal at 2190 m. 1959.

219. **F. thuidioides** Fl.
Tovaiparai Shola at 1790 m. 1926.

METEORIOPSIS (?)

(Derived from the Greek, *meteoros* = high in air, probably with reference to the epiphytic habit of the plant)

220. **M. reclinata** (C.M.) Fl.
Kodaikanal at 1860 m. 1959.

221. **M. squarrosa** (Hook.) Fl.
Shembaganur at 1830 m. 1959.

METEORIUM Brid.

(Derivation similar to that of *Meteoriopsis*)

222. **M. buchanani** (Brid.) Broth.
Kodaikanal at 2183 m. 1912 ; Perumalmalai at 1602 m. 1912.

PAPILLARIA Ehrh.

(Derived from the Latin *papilla* = a minute protuberance, probably referring to the external appearance of the plant)

223. **P. crocea** (Hampe) Jaeg.
Kodaikanal at 2110 m. 1959 ; very common also at Shembaganur, Tiger Shola, Perumalmalai and Manalur.

224. **P. cuspidifera** Card.
Kodaikanal at 1980 m. 1911.

225. **P. fuscescens** (Hook.) Jaeg.
Tiger Shola at 1676 m. 1951.

226. **P. semitorta** (C.M.) Jaeg.
Kodaikanal at 2130 m. 1911.

XXIII. NECKERACEAE

CALYPTOTHECIUM Mitt.

(Derived from the Greek *kalupto* = hidden, *thekion* = a capsule, with reference to the obscure capsule)

*227. **C. oxyphyllum** Dix. & Varde in *Arch. Bot.* 1 : 170, 1927.
Shembaganur at 1830 m. 1923 ; Manalur at 1070 m. 1924.

*228. **C. symphisodontoides** Dix. & Varde in *Arch. Bot.* 1 : 171, 1927.
Manalur at 1070 m. 1924.

HIMANTOCLADIUM Mitt.

(Derived from the Greek *himanto* = strap-like, *kladion* = a shoot, with reference to the external appearance of the plant)

229. **H. rugulosum** (Mitt.) Fl.
Tovaiparai Shola at 1370 m. 1926 ; Periyur at 914 m. 1926.

HOMALIA Brid.

(Derived from the Greek *homalos* = flattened, with reference to the complanate leaves)

230. **H. pygmaea** (Ren. & Card.) Broth.
Perumalmalai at 1602 m. 1926 ; Tiger Shola at 1706 m. 1959.

*231. **H. pygmaea** (Ren. & Card.) Broth. var. **elongata**. Dix. & Varde in *Arch. Bot.* 1 : 182, 1927.
Perumalmalai at 1670 m. 1927.

HOMALIODENDRON (?)

(Derived from the Greek *homalos* = flattened, *dendron* = a shrub, with reference to the habit of the plant)

232. **H. exiguum** Fl.
Tiger Shola at 1780 m. 1926 ; Periyur at 1220 m. 1926.

233. **H. flabellatum** (Dick.) Fl.
Kodaikanal at 2110 m. 1959 ; Tovaiparai Shola at 1370 m. 1959.

234. **H. microdendron** (Hook.) Jaeg.
Tiger Shola at 1706 m. 1912.

HOMALIOPSIS Dix. & Varde in *Ann. Crypt. Exot.* 1 : 48, 1928.

(Derivation similar to that of *Homalia*)

*235. **H. targioniana** (Gough.) Dix. & Varde in *Ann. Crypt. Exot.* 1 : 48, 1928.
Tiger Shola at 1350 m. 1926 ; Tovaiparai at 1370 m. 1926 ; Manalur at 915 m. 1926.

NECKERA Hedw.

(After Necker)

*236. **N. andrei** Thér. & Varde in *Rev. Bryol.* 50 : 74, 1923 ; *Arch. Bot.* 1 : 182, 1927.
Locality unspecified, 1920.

237. **N. exserta** Hook.
Shembaganur at 1830 m. 1909.

*238. **N. pennata** (Lind.) Hedw. var. **rhytidiodonta** Dix. & Varde in *Ann. Crypt. Exot.* 1 : 44, 1928.
Manalur at 914 m. 1923.

239. **N. pygmaea** Ren. & Card.
Kodaikanal at 2130 m. 1921.

*240. **N. semicrispa** Card. & Varde in *Rev. Bryol.* 50 : 74, 1923.
Kodaikanal at 2133 m. 1909.

NECKERIOPSIS Reich.

(Derivation similar to that of *Neckera*)

241. **N. exserta** (Hook.) Broth.
Locality unspecified, 1912.

PINNATELLA C.M.

(Derived from the Latin *pinnatus* = winged, probably with reference to the external appearance of the plant)

242. **P. alopecuroides** (Hook.) Fl.
Tovaiparai Shola at 1370 m. 1926.

*243. **P. foreauana** Thér. & Varde in *Rev. Bryol.* 52 : 39, 1925 ; *Arch. Bot.* 1 : 182, 1927
Shembaganur at 1830 m. 1911, 1959 ; Kodaikanal at 2130 m. 1911, 1959 ; Perumalmalai at 1676 m. 1959 ; Tovaiparai at 1370 m. 1959.

THAMNIUM (?)

(Derived from the Greek *thamnios* = bushy, with reference to the habit of the plant)

244. **T. alopecurum** Lind.
Kodaikanal at 2130 m. 1926, 1956 ; Tovaiparai Shola at 1370 m. 1959.

XXIV. HOOKERIACEAE

DISTICHOPHYLLUM Doz. & Molk.

(Derived from the Greek *distichos* = in rows of two, *phyllon* = leaf, with reference to the mode of arrangement of leaves)

*245. **D. madurense** Thér. & Varde in *Rev. Bryol.* 52 : 40, 1925.
Kodaikanal at 2133 m. 1912, 1930.

246. **D. succulentum** (Mitt.) Broth.
Kodaikanal at 2133 m. 1959.

HOOKERIA Sm.

(After Hooker, Sir William Jackson [1785-1865], the English botanist)

247. **H. acutifolia** Hook.
Shembaganur at 2103 m. 1958.

HOOKERIOPSIS Besch.

(Derivation similar to that of *Hookeria*)

248. **H. utacamundiana** (Mont.) Broth.
Tiger Shola at 1350 m. 1958.

LEPIDOPILIDIUM C.M.

(Derived from the Greek *lepido* = a scale, *pilos* = a cap)

249. **L. furcatum** (Thw. & Mitt.) Broth.
Kodaikanal at 2133 m. 1925.

XXV. SYMPHYODONTACEAE

SYMPHYODON Mont.

(Derived from the Greek *symphous* = joined, *odous* = a tooth, probably with reference to the peristome)

*250. **S. acuminatus** Dix. & Varde in *Ann. Crypt. Exot.* 3 (4) : 180, 1930.
Kodaikanal at 2133 m. 1929.

251. **S. angustus** (C.M.) Jaeg.
Law's Ghat Road at 1676 m. 1959.

252. **S. perrottetii** Mont.
Kodaikanal at 2133 m. 1958.

SYMPHYODONTELLA (?)

(Derivation similar to that of *Symphyodon*)

253. **S. involuta** Thw. & Mitt.
Perumalmalai at 1602 m. 1925.

XXVI. HYPOPTERYGIACEAE

HYPOPTERYGIUM Brid.

(Derived from the Greek *hupo* = under, *pteryg* = a wing)

254. **H. javanicum** Hampe
Kodaikanal at 2133 m. 1958 ; very common also at Shembaganur, Tiger Shola and Perumalmalai.

255. **H. tenellum** Mitt.
Law's Ghat Road at 1737 m. 1959 ; very common in the sholas of Shembaganur, Tiger Shola, Perumalmalai, Tovaiparai and Manalur, 1959.

XXVII. FABRONIACEAE

ANACAMPTODON Brid.

(Derived from the Greek *anacamptos*=recurved, *odous*=a tooth, probably with reference to peristome teeth)

*256. **A. validinervis** Dix. & Varde in *Arch. Bot.* 1 : 172, 1927.
Tovaiparai Shola at 1371 m. 1926.

FABRONIA Raddi.

(After a proper name)

257. **F. goughii** Mitt.
Neutral Saddle at 1570 m. 1926.

*258. **F. madurensis** Dix. & Varde in *Arch. Bot.* 1 : 171, 1927.
Periyur at 1060 m. 1026 ; Shembaganur at 1828 m. 1959 ; Kodaikanal at 2133 m. 1959.

259. **F. secunda** Mont.
Perumalmalai at 1602 m. 1959.

JURATZKAEA C.M.

(After Juratzka [d. 1879], an Austrian botanist)

*260. **J. indica** Broth. & Varde in *Rev. Bryol.* 52 : 40, 1925.
Neutral Saddle at 1562 m. 1959 ; Kodaikanal at 2133 m. 1959.

SCHWETSCHKEA C.M.

(After a proper name)

261. **S. applanata** (Thw. & Mitt.) Broth.
Neutral Saddle, Path to Palni, at 1562 m. 1959 ; Manalur at 1060 m. 1959.

262. **S. indica** Broth.
Tovaiparai Shola at 1370 m. 1959.

XXVIII. LESKEACEAE

PSEUDOLESKEOPSIS (?)

(Derived from the Greek *pseudo* = false, and *leskeopsis* = resembling *Leskea*, itself a genus derived from a proper name)

*263. **P. perfalcata** Dix. & Varde in *Arch. Bot.* 1 : 172, 1927.
Perumalmalai at 1562 m. 1959.

RHEGMATODON Brid.

(Derived from the Greek *rhegma* = cleft, *odous* = a tooth, with reference to the peristome)

264. **R. orthostegius** Mont.
Kodaikanal at 1859 m. 1959 ; Perumalmalai at 1562 m. 1959 ; Tovaiparai Shola at 1371 m. 1959.

265. **R. polycarpus** (Griff.) Mitt.
Shembaganur at 1830 m. 1909.

XXIX. THUIDIACEAE

CLAOPODIUM (?)

(Derived from the Greek *klao* = break, *podion* = a small foot)

266. **C. prionophyllum** C.M.
Shembaganur at 1820 m. 1959 ; Manalur at 914 m. 1959.

HAPLOCLADIUM C.M.

(Derived from the Greek *haplo* = single, *kladion* = a shoot, with reference to the habit of the plant)

*267. **H. vestitum** Dix. & Varde in *Arch. Bot.* 1 : 172, 1927.
Kodaikanal at 2133 m. 1959.

HERPETINEURON C.M.

(Derived from the Greek *herpetos* = creeping, *neuron* = a sinew)

268. **H. toccoae** (Sull. & Lesq.) Card.
Tiger Shola at 1706 m. 1959.

THUIDIUM B.E.

(Derived from the Latin *thuja*, the botanical name of a conifer tree, with reference to similarity in external form)

269. **T. brotheri** Salm.
Kodaikanal at 2130 m. 1959 ; Perumalmalai at 1676 m. 1959 ; Tovaiparai at 1371 m. 1959.

270. **T. cymbifolium** Doz. & Molk.
Kodaikanal at 2130 m. 1959 ; Shembaganur at 1830 m. 1959 ; Perumalmalai at 1676 m. 1959.

271. **T. glaucinoides** Broth.
Tiger Shola at 1602 m. 1959.

272. **T. glaucinum** Mitt.
Kodaikanal at 2194 m. 1926 ; Shembaganur at 1830 m. 1956 ; Tiger Shola at 1602 m. 1959 ; Perumalmalai at 1602 m. 1959.

273. **T. meyenianum** Hampe
Shembaganur at 1840 m. 1959 ; Tovaiparai at 1371 m. 1958 ; Manalur at 914 m. 1959.

274. **T. tamariscellum** C.M.
Kodaikanal at 2194 m. 1959 ; Tiger Shola at 1676 m. 1958 ; Manalur at 1067 m. 1926.

*275. **T. trachilocarpum** Dix. & Varde in *Ann. Crypt. Exot.* 1 : 44, 1928.
Tiger Shola at 1350 m. 1927.

XXX. AMBLYGOSTEGIACEAE

AMBLYSTEGIELLA (?)

(Derived from the Greek *ambly* = blunt, *stegeon* = a roof, with reference to the shape of the lid of the capsule)

*276. **A. madurensis** Card. & Varde in *Rev. Bryol.* 50 : 78, 1923.
Kodaikanal, Pambar Ravine, at 2300 m. 1912.

PLATYHYPNIDIUM W.P.Sch.

(Derived from the Greek *platus* = large, *hypnidion* = hypnon (moss)-like, with reference to the size of the plant)

277. **P. mulleri** Broth.
Kodaikanal at 2140 m. 1926 ; Shembaganur at 1830 m. 1959 ; Tovaiparai at 1371 m. 1959.

278. **P. rusciforme** (Neck.) Fl.
Kodaikanal at 2194 m. 1926 ; Perumalmalai at 1602 m. 1926.

XXXI. BRACHYTHECIACEAE

BRACHYTHECIUM B.E.

(Derived from the Greek *brachy* = short, *thekion* = a capsule, with reference to the capsule of the plant)

*279. **B. nitidissimum** Dix. & Varde in *Arch. Bot.* 1 : 173, 1927.
Tiger Shola at 1706 m. 1926.

280. **B. plumosum** (Sw.) Jaeg.
Kodaikanal at 2194 m. 1926 ; Tiger Shola at 1676 m. 1959.

281. **B. procumbens** (Mitt.) Jaeg.
Kodaikanal at 2194 m. 1926 ; Tiger Shola at 1737 m. 1959 ; Perumalmalai at 1602 m. 1959.

HOMALOTHECIUM (?)

(Derived from the Greek *homalos* =flattened, *thekion* = a capsule, with reference to the shape of the capsule)

*282. **H. (?) gracillimum** Dix. & Varde in *Ann. Crypt. Exot.* 3 (4) : 180, 1930.
Top Station at 1900 m. 1929.

OXYRRHYNCHIUM B.E.

(Derived from the Greek *oxus* = pointed, *rhynchion* = a beak, probably with reference to the capsule)

283. **O. mulleri** (Doz. & Molk.) Broth.
Locality unspecified.

284. **O. ovatum** Card. & Varde
Shembaganur at 1830 m. 1927 ; Tiger Shola at 1750 m. 1959.

PLEUROPUS Griff.

(Derived from the Greek *pleuron* = side, *pous* = a foot, probably with reference to the lateral branches of the plant)

285. **P. fenestratus** Griff.
Kodaikanal at 2190 m. 1926 ; Shembaganur at 1844 m. 1958 ; Perumalmalai at 1602 m. 1958 ; Tovaiparai at 1371 m. 1959.

286. **P. nilghiriensis** (Mont.) Card.
Perumalmalai at 1768 m. 1909.

RHYNCHOSTEGIELLA B.E.

(Derived from the Greek *rhunco* = a beak, *stegos* = a chamber, probably with reference to the capsule)

287. **R. humillima** (Mitt.) Broth.
Manalur at 1060 m. 1926.

*288. **R. leiopoda** Dix. & Varde in *Arch. Bot.* 1 : 174, 1927.
Tovaiparai Shola at 1371 m. 1927.

RHYNCHOSTEGIUM B.E.

(Derivation similar to that of *Rhynchostegiella*)

289. **R. gathicum** Card.
Tiger Shola at 1676 m. 1912.

290. **R. javanicum** Besch.
Kodaikanal at 2130 m. 1926 ; Tiger Shola at 1676 m. 1958 ; Periyur at 1060 m. 1958.

291. **R. vagans** (Harv.) Jaeg.
Tiger Shola at 1750 m. 1959 ; Tovaiparai Shola at 1676 m. 1958 ; Manalur at 1067 m. 1958.

XXXII. ENTODONTACEAE

CAMPYLODONTIUM Schw.

(Derived from the Greek *campylos* = bent, *odous* = a tooth, probably with reference to the peristome teeth)

292. **C. flavescens** Hook.
Perumalmalai at 1737 m. 1926.

ENTODON C.M.

(Derived from the Greek *entos* = within, *odous* = a tooth, probably with reference to the peristome teeth)

293. **E. chloropus** Ren. & Card.
Manalur at 914 m. 1926.

*294. **E. obtustatus** Card. & Varde in *Rev. Bryol.* 50 : 76, 1923 ; ibid. 51 : 12, 1924.
Shembaganur at 1829 m. 1912 ; Tiger Shola at 1676 m. 1958 ; Tovaiparai Shola at 1371 m. 1959.

*295. **E. perplicatus** Thér. & Varde in *Rev. Bryol.* 50 : 75, 1923.
Kodaikanal at 2133 m. 1926 ; Manalur at 940 m. 1958.

296. **E. plicatus** C.M.
Shembaganur at 1905 m. 1959 ; Tiger Shola at 1676 m. 1959 ; Law's Ghat Road at 680 m. 1959.

*297. **E. plicatus** C.M. var. **dimorphophyllus** Dix. & Varde in *Arch. Bot.* 1 : 182, 1927.
Shembaganur at 1830 m. 1959 ; Tiger Shola at 1676 m. 1959.

ERYTHRODONTIUM Hampe

(Derived from the Greek *erythros* = red, *odous* = a tooth, with reference to the colour of the peristome teeth)

298. **E. julaceum** (Hook.) Par.
Kodaikanal at 2133 m. 1959 ; Tiger Shola at 1798 m. 1959 ; Tovaiparai at 1676 m. 1959 ; Manalur at 1239 m. 1958 ; Law's Ghat Road at 700 m. 1959.

NANOTHECIUM Dix. & Varde in *Ann. Crypt. Exot.* 3 (4) : 181, 1930.

(Derived from the Greek *nano* = dwarf, *thekion* = a little vessel, with reference to the size of the capsule)

*299. **N. foreaui** Dix. & Varde in *Ann. Crypt. Exot.* 3 (4) : 181, 1930.
Top station at 1950 m. 1929.

TRACHYPHYLLUM (?)

(Derived from the Greek *trachy* = narrow, *phyllon* = a leaf, with reference to the leaf)

*300. **T. elongatum** Dix. & Varde in *Rev. Bryol.* 52 : 40, 1925 ; *Arch. Bot.* 1: 182, 1927.
Kodaikanal at 2057 m. 1912, 1925 ; Shembaganur at 1828 m. 1959 ; Tiger Shola at 1676 m. 1959 ; Tovaiparai Shola at 1371 m. 1959 ; Manalur at 914 m. 1958.

301. **T. inflexum** (Harv.) Griff.
Palamalai at 1237 m. 1927.

XXXIII. PLAGIOTHECIACEAE

PLAGIOTHECIUM B. & S.

(Derived from the Greek *plagio* = oblique, *thekion* = a little vessel, with reference to the usually oblique capsule)

*302. **P. neckeroideum** B.E. var. **madurenese** Dix. & Varde in *Arch. Bot.* 1 : 183, 1927.
Shembaganur at 1830 m. 1913.

*303. **P. vesiculariaeopsis** Dix. & Varde in *Arch. Bot.* 1 : 174, 1927.
Tiger Shola at 1676 m. 1927.

STEREOPHYLLUM Mitt.

(Derived from the Greek *stereos* = rigid, *phyllon* = a leaf, with reference to the leaf)

304. **S. confusum** Card.
Palamalai at 914 m. 1927.

305. **S. indicum** (Bel.) Mitt.
Manalur at 920 m. 1926.

*306. **S. papilidens** Card. in *Rev. Bryol.* 50 : 77, 1923 ; ibid. 51 : 12, 1924.
Shembaganur at 1830 m. 1909.

*307. **S. subacuminatum** Dix. & Varde in *Ann. Crypt. Exot.* 3 (4) : 182, 1930.
Top Station at 1900 m. 1929.

308. **S. wightii** (Mitt.) Jaeg.
Perumalmalai at 1670 m. 1927 ; Manalur at 914 m. 1958.

XXXIV. SEMATOPHYLLACEAE

APTYCHELLA (?)

(Derived from the Greek *aptuchos* = adpressed, with reference to the leaves of the plant)

309. **A. serrulatae** (Card. & Varde) Broth.
Perumalmalai at 1676 m. 1912.

CLASTOBRYELLA (?)

(Derived from the Greek *klastos* = broken, *bryon* = a moss, with reference to the external appearance of the plant)

310. **C. ceylonensis** Broth.
Kodaikanal at 2130 m. 1912 ; Perumalmalai at 1706 m. 1959.

*311. **C. gracilis** Varde in *Rev. Bryol.* 52 : 41, 1925.
Shembaganur at 1866 m. 1912 ; Perumalmalai at 1676 m. 1959.

CLASTROBRYUM Doz. & Molk.

(Derivation similar to that of *Clastobryella*)

*312. **C. barbelloides** Dix. & Varde in *Arch. Bot.* 1 : 174, 1927.
Shembaganur at 1830 m. 1926 ; Perumalmalai at 1676 m. 1958.

313. **C. ceylonense** Broth.
Kodaikanal at 2133 m. 1929.

314. **C. cupressinoides** Dix. & Varde
Kodaikanal at 2140 m. 1912.

*315. **C. oligonema** Card. & Varde in *Rev. Bryol.* 50 : 74, 1923; ibid. 51 : 12, 1924.
Kodaikanal at 2190 m. 1911.

*316. **C. patentifolium** Dix. & Varde in *Arch. Bot.* 1 : 174, 1927.
Tiger Shola at 1776 m. 1926 ; Perumalmalai Shola at 1670 m. 1926 ; Tovaiparai at 1371 m. 1958.

*317. **C. serrulatum** Card. & Varde in *Rev. Bryol.* 50 : 75, 1923.
Kodaikanal at 2100 m. 1909.

FOREAUELLA Dix. & Varde

(After Foreau, Eugene Armand, *dit* Georges [b. 1882], the author of this paper)

*318. **F. indica** Dix. & Varde in *Arch. Bot.* 1 : 175, 1927.
Manalur at 914 m. 1924 ; Pannaikadu at 1371 m. 1959 ; Mulayur at 1360 m. 1924 ; Periyur at 914 m. 1924 ; Shembaganur at 2103 m. 1959.

GLOSSADELPHUS (?)

(Derived from the Greek *glosa* = a tongue, *adelphos* = double, with reference to the calyptra)

319. **G. anisopterus** (Card. & Varde) Broth.
Kodaikanal at 2133 m. 1928.

320. **G. isopterygioides** (Dix.) Broth.
Tovaiparai at 1371 m. 1927.

321. **G. vivicolor** (Broth. & Dix.) Broth.
Shembaganur at 1860 m. 1928 ; Perumalmalai at 1676 m. 1959.

322. **G. zollingeri** (C.M.) Fl.
Perumalmalai at 1602 m. 1928 ; Periyur at 914 m. 1928.

RHAPHIDIORRHYNCHUM W.P. Sch.

(Derived from the Greek *rhaphus* = a needle, *rhynchion* = a beak, probably with reference to the shape of the capsule)

323. **R. leptorrhynchioides** (C.M.) Broth.
Kodaikanal at 1990 m. 1959 ; Shembaganur at 1828 m. 1959 ; Perumalmalai at 1602 m. 1959.

RHAPHIDOSTEGIUM B.E.

(Derived from the Greek *rhaphus* = a needle, *stegos* = chamber, with reference to the shape of the capsule)

*324. **R. sebillei** Broth. & Thér. in *Rev. Bryol.* 51 : 10, 1924.
Locality unspecified.

RHAPHIDOSTICHUM (?)

(Derived from the Greek *rhaphis* = a needle, *stichos* = row)

325. **R. camptocladum** Card.
Kodaikanal at 1980 m. 1911.

326. **R. cucullifolium** (Card. & Dix.) Broth.
Shembaganur at 1866 m. 1926.

327. **R. subleptocarpum** (Thér. & Varde) Broth.
Shembaganur at 1870 m. 1959.

SEMATOPHYLLUM Mitt.

(Derived from the Greek *sema* = character, *phyllon* = a leaf, with reference to the distinctive leaf structure)

328. **S. caespitosum** (Bruch.) Mitt.
Kodaikanal at 2140 m. 1927 ; Law's Ghat Road at 1676 m. 1959.

*329. **S. cucullifolium** Card. & Dix. in *Rec. Bot. Surv. India.* 6 (3) : 88, 1914.
Shembaganur at 1870 m. 1911.

330. **S. subhumile** (C.M.) Fl.
Shembaganur at 1813 m. 1959 ; Tovaiparai Shola at 1371 m. 1959.

*331. **S. subleptocarpum** Thér. & Varde in *Rev. Bryol.* 51 : 11, 1924.
Shembaganur at 1850 m. 1909.

TAXITHELIUM Mitt.

(Derivation uncertain)

332. **T. isopterygioides** Dix.
Tovaiparai Shola at 1371 m. 1911.

333. **T. vivicolor** Broth. & Dix.
Shembaganur at 1860 m. 1911.

WARBURGIELLA C.M.

(After Warburg)

*334. **W. isopterygioides** Dix. & Varde in *Ann. Crypt. Exot.* 3 (4) : 183, 1930.
Shembaganur, on a shrub, near the Church at 1870 m. 1929.

*335. **W. perviridis** Dix. & Varde in *Arch. Bot.* 1 : 176, 1927.
Kodaikanal at 2133 m. 1959 ; Tiger Shola at 1750 m. 1959 ; Perumalmalai at 1602 m. 1959.

XXXV. HYPNACEAE

CTENIDIUM W.P. Sch.

(Derived from the Greek *ctenidion* = a comb)

†336. **C. lychnites** (Mitt.) Broth.
Kodaikanal at 2103 m. 1959 ; Shembaganur at 1828 m. 1959 ; Tiger Shola at 1676 m. 1959 ; Perumalmalai at 1602 m. 1959.

ECTROPOTHECIUM Mitt.

(Derived from the Greek *ectropos* = bent, *thekion* = a capsule, with reference to the shape of the capsule)

*337. **E. andrei** Card. & Varde in *Rev. Bryol.* 50 : 78, 1923 ; *Arch. Bot.* 1 : 183, 1927 ; *Ann. Crypt. Exot.* 3 (4) : 191, 1930.
Kodaikanal at 2133 m. 1926 ; Shembaganur at 1905 m. 1959 ; Perumalmalai at 1562 m. 1959.

*338. **E. anisopterum** Card. & Varde in *Rev. Bryol.* 50 : 79, 1923.
Kodaikanal at 2130 m. 1909.

339. **E. cyperoides** (Hook.) Jaeg.
Shembaganur at 1830 m. 1959 ; Tovaiparai Shola at 1371 m. 1959 ; Manalur at 914 m. 1959.

*340. **E. densum** Dix. & Varde in *Arch. Bot.* 1 : 176, 1927.
Tiger Shola at 1745 m. 1926.

*341. **E. drepanocladioides** Broth. & Varde in *Rev. Bryol.* 52 : 41, 1925 ; *Arch. Bot.* 1 : 182, 1927.

342. **E. laevigatum** Thw. & Mitt.
Perumalmalai at 1602 m. 1926.

343. **E. viride** Card.
Kodaikanal at 2130 m. 1909.

HYPNUM Dill.

(Derived from the Greek *hypnon* = a moss)

344. **H. cupressiforme** Lind.
Kodaikanal at 2103 m. 1959 ; Shembaganur at 1828 m. 1959.

ISOPTERYGIUM Mitt.

(Derived from the Greek *isos* = even, *pterygium* = a leafy branch, with reference to the symmetry of the plant body)

345. **I. albescens** (Schp.) Jacq.
Kodaikanal at 2130 m. 1911.

346. **I. arquifolium** Jaeg.
Kodaikanal at 2140 m. 1959 ; Shembaganur at 1866 m. 1926 ; Perumalmalai at 1602 m. 1959.

347. **L. distichaceum** (Mitt.) Jaeg.
Shembaganur at 1830 m. 1958.

348. **I. minutirameum** (C.M.) Jaeg.
Kodaikanal at 2133 m. 1958.

*349. **I. subleptotapes** Card. & Varde in *Rev. Bryol.* 51 : 12, 1924.
Shembaganur at 1830 m. 1912.

350. **I. taxirameum** Mitt.
Kodaikanal at 1980 m. 1909.

351. **I. textori** (Lac.) Mitt.
Tiger Shola at 1676 m. 1926 ; Old Ghat Road at 1750 m. 1959.

TAXIPHYLLUM (?)

(Derived from the Greek *taxiphullus* = whose leaves are disposed symmetrically)

352. **T. taxirameum** (Mitt.) Fl.
Kodaikanal at 2130 m. 1959; Tovaiparai Shola at 1371 m. 1959; Periyur at 914 m. 1959.

VESICULARIA C.M.

(Derived from the Latin *vesicula,* meaning a small bladder)

*353. **V. firma** Dix. & Varde in *Ann. Crypt. Exot.* 3 (4) : 184, 1930.
Central station at 1830 m. 1929.

*354. **V. nitidula** Card. & Varde in *Rev. Bryol.* 51 : 10, 1924 ; ibid. 52 : 44, 1925.
Kodaikanal at 2130 m. 1926 ; Perumalmalai at 1602 m. 1959.

*355. **V. sulbilicuspis** Card. & Varde in *Rev. Bryol.* 50 : 79, 1923 ; *Arch. Bot.* 1 : 183, 1927 ; *Ann. Crypt. Exot.* 3 (4) : 191, 1930.
Kodaikanal at 2133 m. 1959 ; Shembaganur at 1828 m. 1958 ; Tovaiparai Shola at 1371 m. 1959.

XXXVI. HYLOCOMIACEAE

Macrothamniella (?)

(Derived from the Greek *macro* = large, *thamnos* = a shrub)

356. **M. pilulosa** (Mitt.) Fl.
Kodaikanal at 2140 m. 1959; Perumalmalai at 1602 m. 1959; Manalur at 914 m. 1959.

Macrothamnium (?)

(Derivation similar to that of *Macrothamniella*)

357. **M. macrocarpum** (Rein. & Hsch.) Fl.
Kodaikanal at 2103 m. 1959; Perumalmalai at 1676 m. 1959.

358. **M. submacrocarpum** (Hampe) Fl.
Kodaikanal at 2140 m. 1959; Levinge Path at 1981 m. 1959.

XXXVII. DIPHYSCIACEAE

Diphyscium (Ehrh.) Mohr.

(Derived from the Greek *di* = two, *physke* = bladder, with reference to the double tissue of the exothecium and sporangium, which are very distinct in this genus)

359. **D. fasciculatum** Mitt.
Tiger Shola at 1676 m. 1926.

360. **D. involutum** Mitt.
Shembaganur at 1830 m. 1926.

XXXVIII. POLYTRICHACEAE

Catharinea Ehrh.

(After Empress Catherine II of Russia)

*361. **C. aculeata** (Card. & Varde) Broth. in *Rev. Bryol.* 50 : 25, 1923, as *Atrichum aculeatum* Card. & Varde.
Kodaikanal at 2194 m. 1959; Perumalmalai at 1602 m. 1959; Manalur at 914 m. 1959.

Pogonatum P.B.

(Derived from the Latin *pogon* = a beard, with reference to the hairy calyptra)

†362. **P. aloides** (Hedw.) Pal.
Kodaikanal at 2190 m. 1959.

†363. **P. hexagonum** Mitt.
Kodaikanal at 2130 m. 1959.

364. **P. inflexum** Lind.
Perumalmalai at 1602 m. 1959.

365. **P. junghuhnianum** Doz. & Molk.
Kodaikanal at 2130 m. 1959.

†366. **P. microstomum** (R. Br.) Brid.
Shembaganur at 1830 m. 1959 ; Old Ghat Road at 1750 m. 1959 ; Perumalmalai at 1662 m. 1959.

367. **P. neesii** (C.M.) Mitt.
Kodaikanal at 2140 m. 1959 ; Shembaganur at 1820 m. 1959 ; Tiger Shola at 1676 m. 1959 ; Perumalmalai at 1602 m. 1959 ; Manalur at 914 m. 1959.

*368. **P. subperichaetiale** Card. & Varde in *Rev. Bryol.* 50 : 25, 1923.
Kodaikanal, Pambar Ravine, on moist ground at 2400 m. 1912.

ACKNOWLEDGEMENTS

The author wishes to put on record the award of a generous financial grant by the Bombay Natural History Society which made the explorations of 1959 possible. His thanks are also due to A. Mariakulandai, S.J., for frequent assistance in the field, to Fr. J. Vincent, S.J. and A. Simon, S.J., for preparing the map, to Fr. F. Gilmore, S.J., for checking the derivation of generic names from Greek or Latin, to A. H. Norkett, British Museum (Natural History), for help in identifying many of the Palni Hills mosses, especially of the genus *Fissidens*, and to Fr. H. Santapau, S.J., for his kind suggestions in preparing the manuscript.

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Taxonomic notes on *Sardia rostrata* Melichar [Homoptera, Fulgoroidea, Delphacidae (=Araeopidae)]

BY

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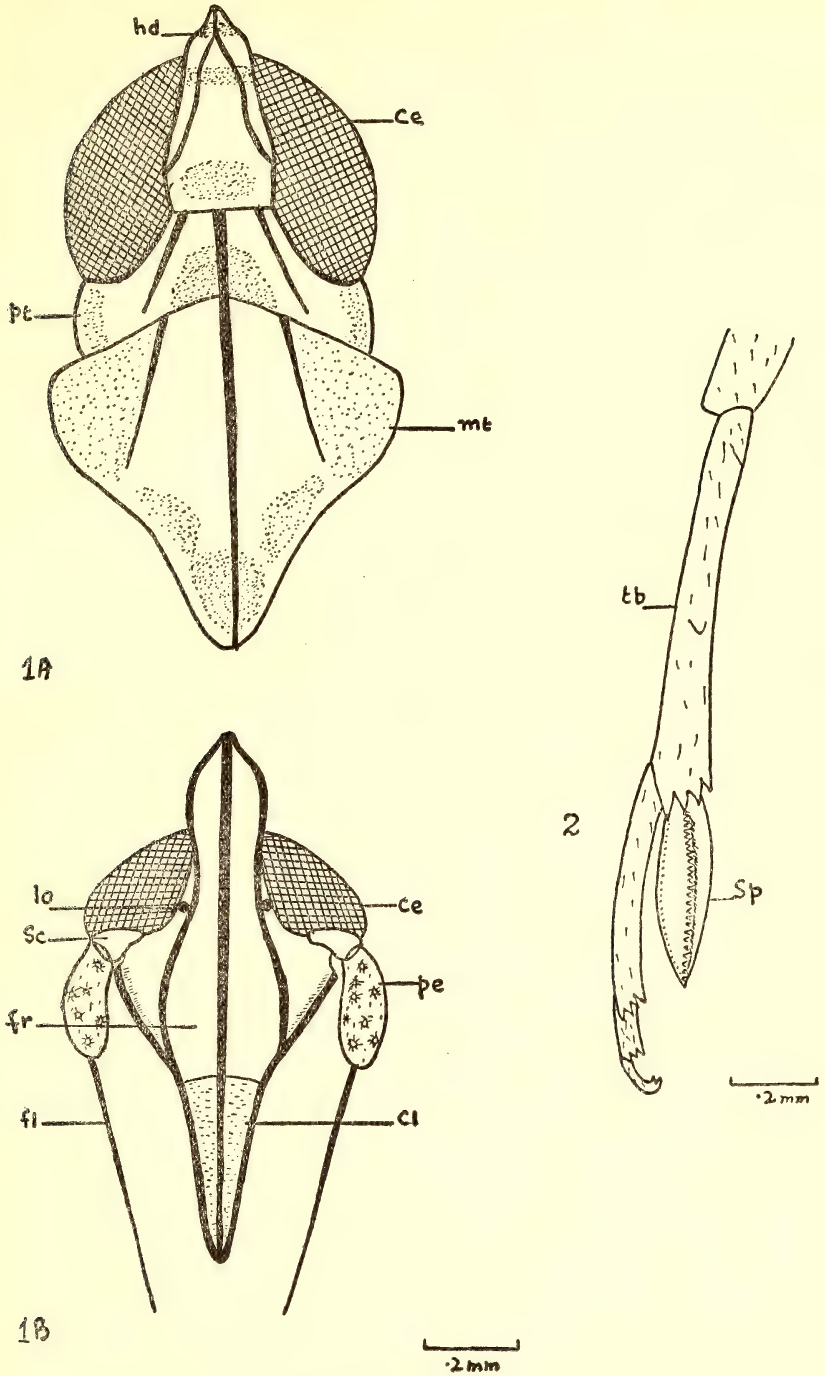
(*With two plates*)

INTRODUCTION

The genus *Sardia* was erected in 1903 with *Sardia rostrata* as the type and was first reported from India by Distant in 1916 and by Muir in 1922. In India, the species has so far been reported from Bombay, Kerala, and Bengal. It is recorded here for the first time from Rajasthan. The author collected specimens of the species from Ajmer (475 metres above m.s.l.) and Mount Abu (1200 metres above m.s.l.).

GENERAL DESCRIPTION

Sardia rostrata is a comparatively large-sized Araeopid. The females are bigger than the males. Only the macropterous forms have so far been collected. The female measures 5mm. long and the male 4mm. (from vertex to the tip of the abdomen). They are beautifully coloured, and in profile appear dark brown, with scattered pale yellow marks. The pale yellow colour is more pronounced in the male. The head and thorax bear alternate bands of dark brown and pale yellow patches. On the mesothorax there is an enlarged pale yellow area in the middle, with two lateral and one posterior dark brown markings. The posterior extremity of the prothorax has a whitish patch, with a narrow extension of the same as a longitudinal strip on the tegmen up to the anterior one-third. On the ventral side, the dark brown colour is deeper and is without the yellow patches.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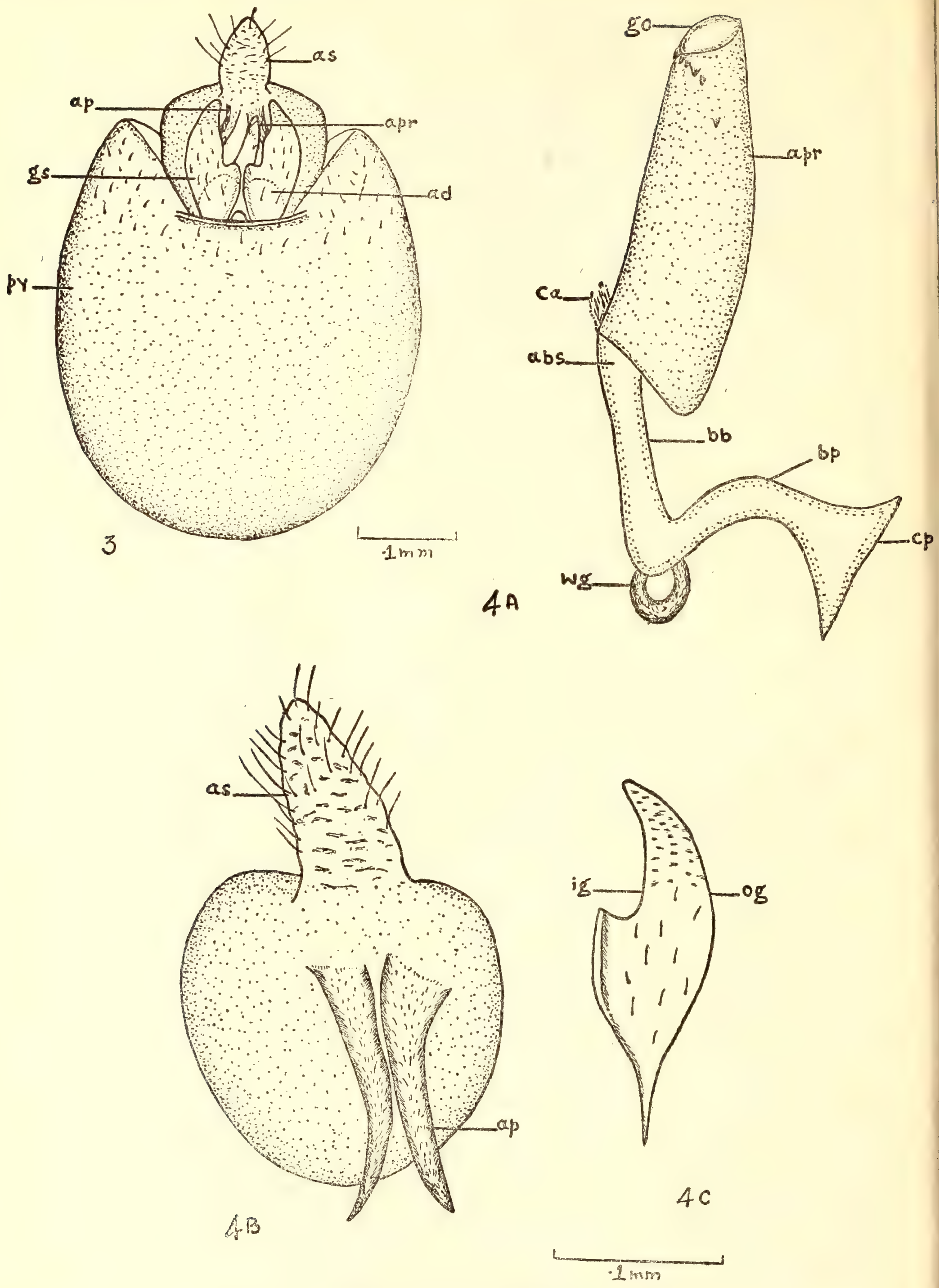
Sardia rostrata Melichar

Fig. 1A : Dorsal view of head, pronotum, and mesonotum ; Fig. 1B : Ventral view of head ; ce : compound eye ; cl : clypeus ; fl : flagellum ; fr : frons ; hd : head ; lo : lateral ocellus ; mt : mesonotum ; pe : pedicel ; pt : pronotum ; sc : scape. Fig. 2 : Hind leg ; sp : spur ; tb : tibia.



Sardia rostrata Melichar

Fig. 3 : Pygofer, ventral view ; ad : armature of diaphragm ; ap : anal process ; apr : aedeagus periandrum ; as : anal style ; gs : genital style ; py : pygofer. Fig. 4A : aedeagus with the basal connections ; Fig. 4B : Fused tenth and eleventh abdominal segments ; Fig. 4C : Single genital style ; abs : aedeagus basal strut ; ap : anal process ; apr : aedeagus periandrum ; as : anal style ; bb : basal plate bridge ; bp : basal plate prolongation ; ca : connection to the anal segment; cp : connection to the genital styles ; go : gonopore ; ig : inner margin of genital style ; og : outer margin of genital style ; wg : ‘ wing ’.

CARINATION

Early taxonomists relied on the carinae on the head and thoracic regions for determining the species. The carinae of the head form an unsatisfactory taxonomic character. Kirkaldy (1907) and Muir (1915) recognised two types of lateral keels on the prothorax, one in which they are almost straight and reach the posterior margin, and a second where they curve under the eyes and do not reach the margin. There are also a number of intermediate types. The carination of the mesothorax is a reliable taxonomic character.

The clypeus is tricarinate, with the two lateral carinae occupying marginal positions with the third in the middle. The middle carina is stouter than the laterals. The frons is five-keeled. The outermost pair are short and situated marginally; they terminate at the basal region of the antennae, at the antennal sclerites. The middle carina is straight and strong. The remaining two carinae are one on either side of the median carina and diverge immediately behind the compound eyes. The lateral carinae run close to the inner margin of the compound eyes and continue to the vertex. There is no median carina on the vertex of *Sardia rostrata* as in many other Araeopids. The two medio-lateral keels of the vertex unite anteriorly to form a Y-shaped carina. It is described as a characteristic feature of the genus *Sardia* by Muir (1915). In *Sardia rostrata* the place of union between the two medio-lateral carinae is well behind the apex of the vertex. The medio-lateral carinae are very faint and appear as a thin ridge. The remaining two carinae, namely the lateral carinae, closely appose the compound eyes. The medio-lateral carinae of the vertex diverge posteriorly and meet the lateral carinae of the same region slightly in front of the posterior margin. The two lateral carinae of the vertex apposing the inner edge of the compound eyes disappear posteriorly in the area of the pronotum. The prothorax is distinctly tricarinate. The lateral carinae are straight and vanish before reaching the posterior margin. The middle carina is stout and joins the mesothoracic middle keel. The mesothorax is also tricarinate, but the lateral carinae are faint and reach a little more than three-fourths of the length of the mesothorax. Though the middle carina is stout and extends up to the posterior extremity it gradually becomes faint towards the posterior margin.

ANTENNAE

The antennae extend well beyond the clypeus. The scape is small and measures only half the length of the pedicel. This is considered to be a primitive condition by Muir (1915). The pedicel is more than double the length of the combined basal two divisions.

SPUR

The hind tibia bears the spur, which is foliaceous with a large number of teeth (between 20 and 25) on the hind margin. The foliaceous type of spur is considered to be the most advanced type by Muir (1915).

GENITALIA

The external male genitalia are considered, at the present time, among the reliable characters for specific determination in the Araeopidae. Kirkaldy (1907) was the first to point out the significance of it in generic determination, and from time to time it was stressed by different authors like Muir (1915), Giffard (1921), Metcalf (1943), and Hassan (1948). Hassan (1948) considered the differences in the female external genitalia also important in the generic determination of Araeopidae.

The external genitalia of the male in Araeopids develop in association with posterior margin of the ninth abdominal segment or pygofer. In *Sardia rostrata* the pygofer is quite conspicuous, because of its larger size. There is no differentiation of tergum, sternum, or pleurite. The tergum of the eighth abdominal segment projects posteriorly into the ninth segment. The opening of the pygofer is longer than broad. The pygofer possesses scattered hairs around its body towards the distal region. There is a triangular notch at the posterior side of it, within which lies the external genitalia. At the posterior side of the pygofer is situated a small projection, formed by the fusion of the tenth and eleventh abdominal segments. These fused segments are partly surrounded by an outgrowth from the posterior side of the pygofer. This is the anal emargination. Looking through the opening of pygofer, one sees a more or less sclerotic wall, dividing it into an inner and an outer chamber, called the diaphragm. It is the sclerotized intersegmental membrane between the ninth and tenth abdominal segments. There is a highly sclerotized region on the diaphragm, supporting the aedeagus, called the armature. The internal genital organs are located behind the diaphragm, whereas the external genital organs are situated in the external chamber. The dorsal margin of the diaphragm is V-shaped. Near the ventral margin of the diaphragm there is a pair of apertures, one on either side of the middle line, and through these project a pair of small sclerites called the genital styles. They are somewhat sickle-shaped. The genital styles are simple, flat, and plate-like structures with the base much broader than the distal region. As the basal regions are hidden by the pygofer, it is difficult to get a complete view of them unless they are dissected out. Their outer margins are convex and entire, whereas the inner margins are concave and wavy. There is an internal projection at the basal angle, i.e. at the inner margin of the basal part of the genital style. The genital styles are hairy, the basal three-fourths being provided with large scattered hairs, and distal one-fourth with small and closely arranged hairs.

The aedeagus arises from the bottom of the inner chamber. It projects over the middle of the diaphragm and is supported by the armature. The aedeagus is cylindrical and slightly curved basally. It is not of uniform calibre, with the basal region stouter than the distal. It is composed of an ejaculatory duct surrounded by a sheath and passes through a large chitinous tube, the aedeagus periandrum. The aedeagus opens externally by the gonopore and through this aperture the ejaculatory duct comes out during the process of copulation. The periandrum carries a few teeth at its distal region directed proximally. Proximally the aedeagus is supported by sclerotized plates, the basal plates of Pruthi (1925). That part of the basal plate to which the aedeagus periandrum is attached is referred to as the aedeagus basal strut. The basal strut is connected to the tenth segment by a small sclerite. The basal plate is composed of two parts, a basal part called the basal plate bridge, and a prolongation from that to the genital styles, the basal plate prolongation. The latter sclerite is bifurcated distally and is attached to the posterior part of the genital styles. At the junction between the basal plate bridge and the basal plate prolongation, there is a chitinous ring, the 'wing' of Hassan (1948). The present author disagrees with the term 'wing' since it is formed of a clear ring, but prefers to retain the name for want of a better appellation. Probably the ejaculatory duct passes through this before entering into the aedeagus periandrum.

The last two abdominal segments in Araeopids, i.e. the tenth and eleventh, are fused to form a single structure (Giffard, 1921). In *Sardia rostrata* it is oval in shape with a distal projection. It is considerably large and hairy. Giffard (1921) has mistaken the tenth segment for the anal segment. The real anal segment is the eleventh one and its appendage is the anal style, a conical projection situated posteriorly. The anus opens on the eleventh segment. Anterior to it is the tenth abdominal segment bearing a pair of anteriorly directed spines, the anal processes. The anal processes are slender and the aedeagus lies in between them in the preserved specimens.

SUMMARY

Sardia rostrata is described from the taxonomic standpoint. The following characters are noteworthy:

1. Clypeus is tricarinate whereas the frons is five-keeled. The medio-lateral carinae of the vertex are fused to form a Y-shaped carina. The prothorax as well as the mesothorax are tricarinate.
2. The antennae extend well beyond the clypeus, with the scape only half the length of the pedicel.
3. The spur is foliaceous with a large number of teeth.
4. The opening of the pygofer is longer than broad.
5. The genital styles are simple and pointed.
6. The aedeagus periandrum has a few basally directed teeth.
7. The anal segment is hairy, with an anal style and a pair of slender anal processes.

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The author wishes to express his indebtedness to Dr. P. N. Mathur, Head of the Zoology Department, Government College, Ajmer, for his guidance and valuable help. He is thankful to Dr. M. G. Ramdas Menon, Systematic Entomologist, I.A.R.I., New Delhi, for identifying the species. His thanks are also due to Shri Bhim Sen, Principal, Government College, Ajmer, for the research facilities granted to him, and to Mr. N. Khattar for help in preparing the plates.

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* Not seen in original.

Critical Notes on the Orchidaceae of Bombay State

V. *EULOPHIA* R. BR. & *AËRIDES* LOUR.

BY

H. SANTAPAU, S.J., F.N.I. AND Z. KAPADIA, PH.D.

(*With five plates*)

[*Continued from Vol.* **57** (3) : 510]

EULOPHIA R. Br.

EULOPHIA R. Br. in Bot. Reg. t. 686, 1823, nom. cons. ; Endl. Gen. Pl. 200, 1837 ; Benth. & Hook. f. Gen. Pl. 3 : 535, 1883 ; Pfitz. in Engl. & Prantl, Pflanzenf. 2 (6): 157, 1889; Hook f. Fl. Brit. Ind. 6 : 1, 1890 ; King & Pantl. in Ann. R. Bot. Gard. Calcutta 8 : 176, 1898 ; Duthie, ibid. 9 (2) : 122, 1906 ; J. J. Smith, Fl. Buitenz. 6 : 223, 1905 ; Schltr. Orchid. 343, 1927 ; Holttum, Rev. Fl. Malaya 1 : 529, 1953. *Graphorkis* Thou. Nouv. Bull. Soc. Philom. Paris 1 : 318, 1809. *Graphorchis* Thou. : O. Kuntze, Rev. Gen. Pl. 2 : 661, 1891.

The generic name comes from the Greek ' eulophus '=' handsome-crested ', in allusion to the handsome lip of the species, which has elevated ridges on the upper surface.

Perennial, terrestrial *herbs*. *Pseudobulbs* tuberous, subterranean or partly above the ground. *Leaves* distichous appearing with the flowers or before them, narrow and grasslike or broad and plicately-veined. *Scape* lateral to the leaves, from the side of the pseudobulb. *Sepals* subequal, free and spreading ; lateral ones often connate at the base with the column-foot. *Petals* similar to the dorsal sepal or broader, spreading or erect and connivent. *Lip* erect and more or less adnate to the base of the column with a small sac at the base in between the lateral sepals, or adnate to the column-foot and produced into a short spur beyond the lateral sepals, 3-lobed or rarely subentire ; lateral lobes erect, surrounding the column, rarely obsolete, midlobe spreading or recurved, often broad, entire or bilobed ; disc variously crested or lamellate in the middle or rarely naked. *Column* thick, with or without a distinct foot, often with 2 lateral wings. *Anther* terminal, opercular, incumbent, imperfectly 2-celled ; pollinia 2, often deeply cleft, waxy, attached to a short broad caudicle and a narrow, flat, disc-shaped gland. *Capsule* ovoid or oblong, pendulous or erect.

A large genus of about 200 species, widely dispersed throughout the tropics and warm regions of both hemispheres. It attains its maximum development in Africa and is distributed from Africa through India, Ceylon, Malaya, China towards Polynesia ; rather rare in Australia and America.

The genus *Eulophia* has been usually divided into 2 distinct sections : *Genuina* Lindl., J. J. Smith (l.c.), (=sect. *Eulophia proper* of Hooker f.) and *Cryptopera* Lindl. The latter is considered by Bentham & Hooker f. to be an independent genus. But, as Hooker f. has pointed out, there is a direct passage from sect. *Cryptopera* to species without a column-foot. The name of the first section, *Genuina* Lindl., or sect. *Eulophia proper*, must be changed to *Eulophia* sect. *Eulophia*, since it contains the type species, *E. barbata* Spreng. (=*Serapias capensis* L.), in accordance with Art. 22 of the Code.

Holttum mentions that *E. zollingeri* J. J. Smith has a saprophytic habit. This seems strange to us ; there are several species (such as *E. pratensis* Lindl., *E. dabia* Hochr. [*E. campestris* Lindl.]) which produce leaves long before flowers ; it is possible that the leaves of *E. zollingeri* J. J. Smith may not have been collected, and therefore the plant appears saprophytic.

Type species : *E. barbata* Spreng. (=*Serapias capensis* L.).

KEY TO THE SPECIES OF *EULOPHIA* OF BOMBAY

1. Column not produced into a distinct foot :
   2. Pseudobulbs epigeal, conical; leaves grass-like, not plicate ; scape branched or not .. *epidendraea*
   2. Pseudobulbs hypogeal, irregularly rounded-conical or ovoid ; leaves elliptic-lanceolate or narrowly lanceolate, plicately-veined ; scape never branched :
      3. Leaves appearing with the flowers, broadly oblong-elliptic :
         4. Flowers about 12 mm. long, deep yellow with a few brown spots ; lip scarcely lobed, minutely saccate at base .. .. .. *ochreata*
         4. Flowers 18-22 mm. long, greenish white, often flushed with pale mauve ; lip 3-lobed, spur 3-4 mm. long, elliptic obtuse .. .. *herbacea*
      3. Leaves appearing much before flowers, narrow, lanceolate or linear-elliptic :

5. Flowers about 11 mm. long, yellowish or green with pink or purple markings .. .. .. *dabia*
5. Flowers about 20 mm. long, pale maroon suffused with yellow .. *ramentacea*
1. Column with a distinct foot .. .. *nuda*

ENUMERATION OF THE SPECIES OF *EULOPHIA* OF BOMBAY STATE

1. **Eulophia epidendraea** (Retz.) Fischer in Gamble, Fl. Pres. Madras 1434, 1928 & in Kew Bull. 1928 : 283. *Serapias epidendraea* Retz. Obs. 6 : 65, 1791. *Limodorum virens* Roxb. Pl. Cor. 1 : 33, t. 38, 1795 & Fl. Ind. 3 : 467, 1832. *L. epidendrioides* Willd. Sp. Pl. 4 : 124, 1805. *Eulophia virens* R. Br. in Bot. Reg. sub. t. 573, 1822 (*Eulophus*) ; Wight, Icon. 3 (2) : 10, t. 913, 1844-1845; Lindl. in Journ. Linn. Soc. 3 : 24, 1859 ; Bot. Mag. t. 5579, 1866. *E. epidendrioides* Schltr. Orchid. 346, 1914. (See Plate XXVI).

Pseudobulbs 3-11 cm. long, about 2-5 cm. broad at the base, epigeal, greenish brown, ovate-conical or obpyriform, with narrow rings; current season's tubers enveloped by sheaths, older ones bare and polished. *Leaves* somewhat withered at the time of flowering, alternate, distichous, sheathing at the base, the upper ones forming a smooth pseudostem about 4 cm. long ; lamina 15-35 × 0.7-2 cm., linear or linear-lanceolate, acute or subacuminate, entire, subcarinate at the base. *Inflorescence* up to 60 cm. long, laxly many-flowered ; peduncle about 3 mm. in diam., greenish purple, glabrous, terete, with a few sheaths, which are 7-20 mm. long, oblong-lanceolate, acute, entire, glabrous. *Flowers* 2.2 × 2.8-3 cm. *Bracts* 8×3 mm. (5 mm. broad when spread out), concave, subacuminate, entire, minutely gland-dotted, glabrous, pale greenish tinged with pale maroon towards the apex ; nerves 7, pale green ; *pedicels* with *ovary* 5-7 mm. long, green. *Sepals* and *petals* subequal, oblong or oblanceolate, acute or mucronulate, entire, glabrous, 5-nerved, light yellowish green with tessellate reddish nerves. *Sepals* 17×5 mm., recurved from a little beyond the middle. *Petals* 17×6 mm., parallel to column and lip, recurved at tips. *Lip* 17×7 mm., oblong or obovate-oblong in outline, 3-lobed ; lateral lobes 10×3 mm., pale green with red, slightly wavy margins, erect, subconnivent along the column, slightly recurved at the obtuse apex, veins red impressed on the inside ; midlobe 7×7-8 mm., greenish, obovate-oblong or obcordate, retuse, mucronulate or not, crenulate. The upper surface of the lip is ridged with 3 purplish red nerves in the centre, the side nerves giving off a faint branch halfway ; the 5-nerves ending in purplish white hairs, on the midlobe. *Spur* 5-7 mm. long, greenish white, slightly bulbous and incurved. *Column*

7×2-3 mm., oblong, clavate rounded at the back, shallowly grooved in front, apiculate, without foot or wings, white tinged with pale mauve at the base. *Anther* 2×1.5 mm., white, panduriform, basal lobe broader, apical lobe purplish red ; pollinia 2, yellow, 1 mm. across, subquadrate-globose, deeply cleft ; caudicle broad, 0.5 mm. long ; gland narrow, linear, about 1 mm. across. *Stigmatic surface* 2 mm. broad, transversely oblong, pale green. *Capsules* 4.5×1.1 cm., oblong, drooping, pale mauve with 3 pale green, broad bands ; pedicels 7-9 mm. long, curved.

Flowering : November to January. *Fruiting :* March.

Occurrence in Bombay State: KONKAN : Bombay, cultivated, *Santapau* 10532 ; *Kapadia* 1843. Tubers of this species were given to H. Santapau in Khandala in 1946 ; since then it has been successfully cultivated in St. Xavier's College, Bombay, where it comes into flower every year.

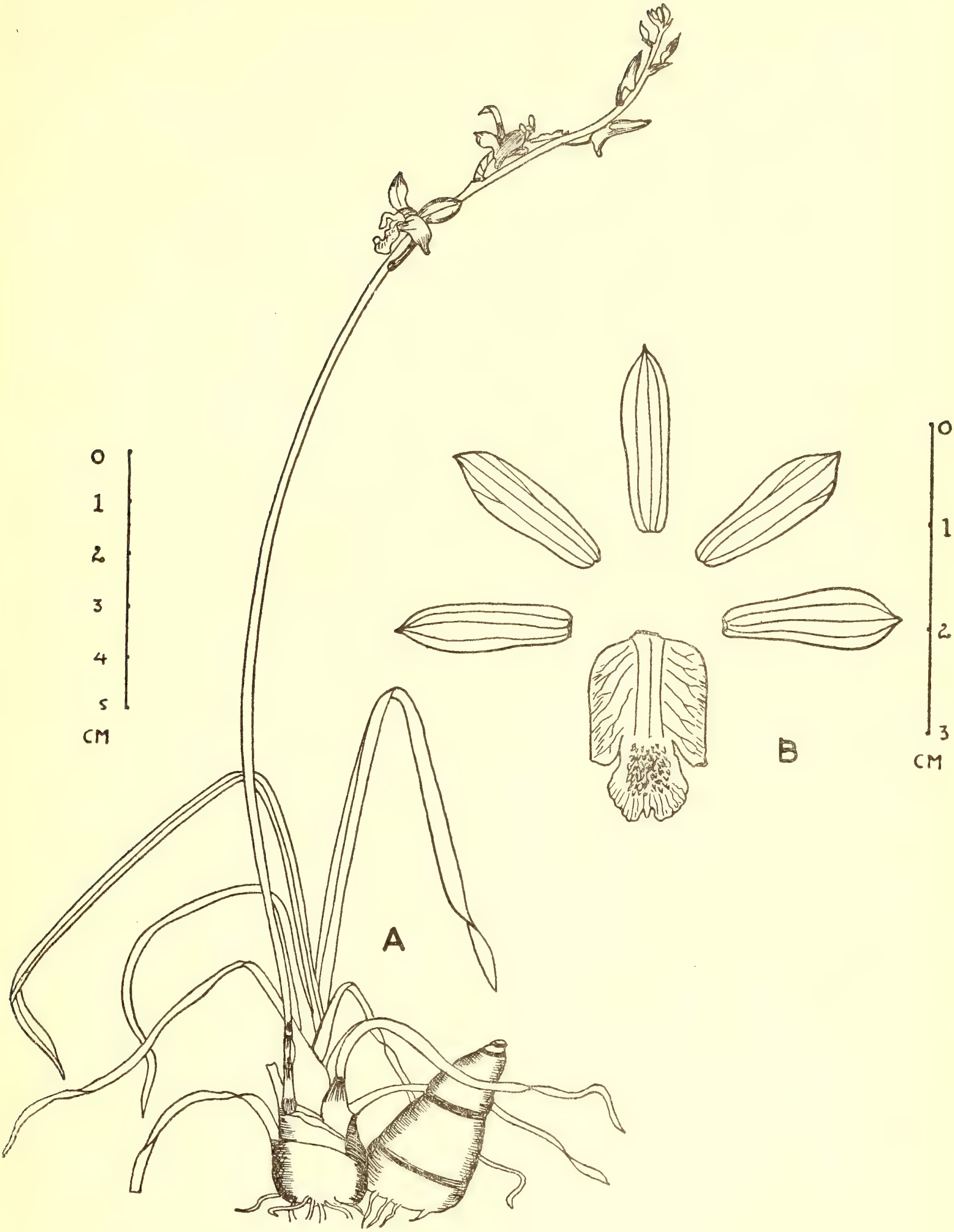
This species has not been recorded previously from Bombay State ; it, therefore, constitutes a new record for this area.

Distribution : W. Ghats, Andhra, and S. India from sea-level to 1000 metres.

Notes : The earliest legitimate epithet for this species is *epidendraea* Retz. which was changed to *epidendrioides* by Willdenow when he transferred it to the genus *Limodorum*. Schlechter in bringing the species to *Eulophia* used *epidendrioides* in the new combination ; the original form is the only valid one, and was reinstated by Fischer.

2. **Eulophia ochreata** Lindl. in Journ. Linn. Soc. 3 : 24, 1858 ; Dalz. & Gibs. 265 ; Hook. f. 2 ; Cooke, Fl. Pres. Bomb. 2 : 693, 1907 ; Gammie in Journ. Bombay nat. Hist. Soc. 18 : 89, 1907 ; Blatt. & McC. ibid. 35 : 485, 1932 ; Fischer 1435 ; Santapau in Rec. Bot. Surv. Ind. 16 (1) : 301, 1953. *Graphorchis ochreata* (Lindl.) O. Kuntze, Rev. Gen. Pl. 2 : 662, 1891. (See Plate XXVII).

Pseudobulbs about 4×2.5 cm., subterranean, ovoid-conical with irregular, transverse and longitudinal markings. *Leaves* 2-5, arising from the base of the pseudobulb, forming a pseudostem 8-23 cm. long ; leaves 13-28×4-10 cm., sheathing at the base, oblong-lanceolate to ovate, or ovate-elliptic, acute, entire, glabrous. *Scape* appearing with the leaves from the pseudostem, 25-45 cm. long, with 2 or 3 sheaths ; the latter are about 2-4 cm. long, purplish brown, acute, somewhat inflated. *Flowers* in dense racemes, clustered at the top of the scape, about 1-1.5 cm. across. *Bracts* 4-13×1-2 mm., narrowly linear, acute, entire, 3-nerved, pale green ; *pedicel* with *ovary* 10-13 mm. long, slightly curved, twisted, faintly yellowish green. *Sepals* 10-14×2-3 mm., yellowish green with purple or brown spots on the inner surface near the base, linear-lanceolate, subacuminate or apiculate, entire, 1-nerved, the dorsal slightly broader. *Petals* 11-14×3.5-4 mm., similar to sepals in colour, broadly ovate-oblong, rarely suboblique, acute, entire, glabrous, faintly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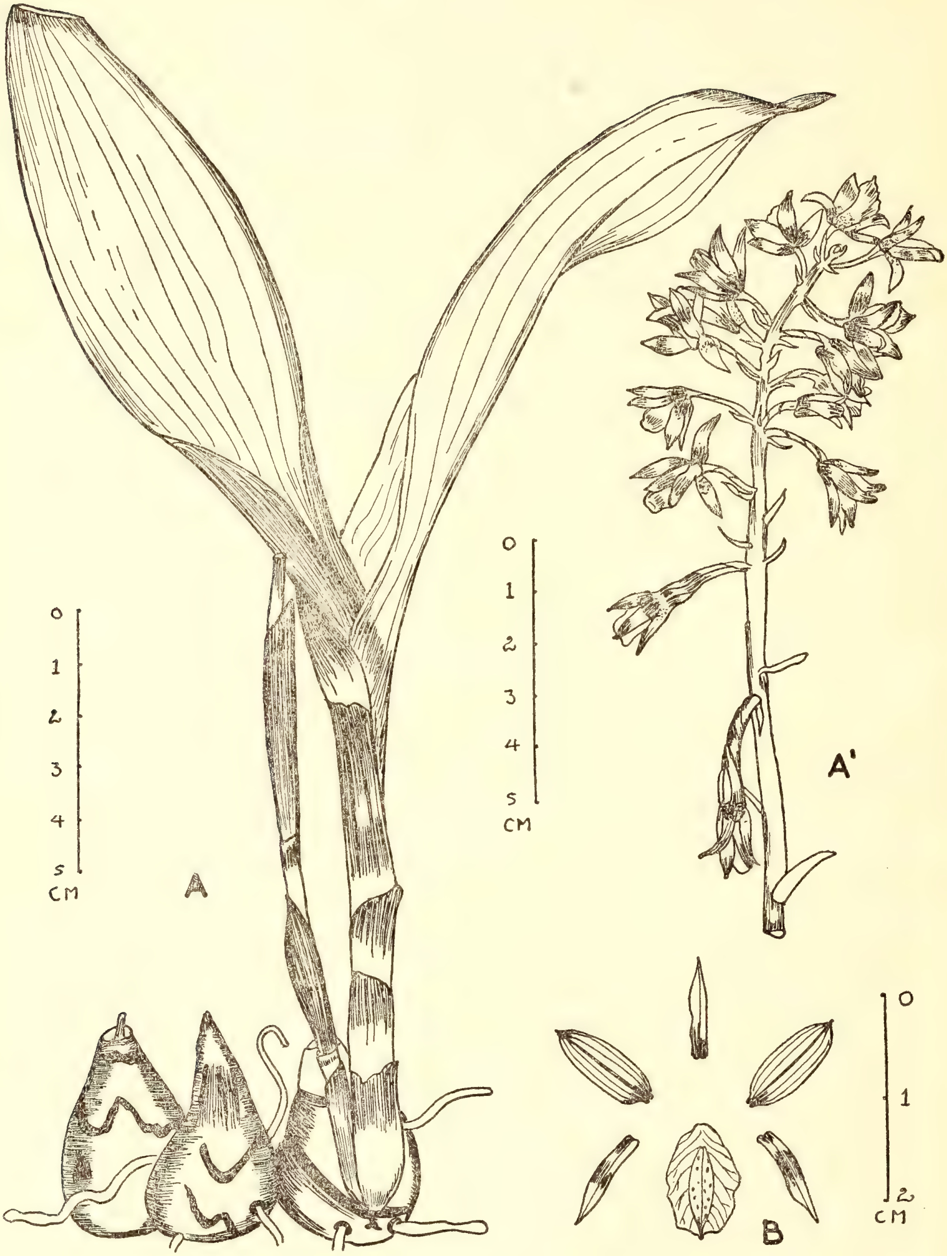
Eulophia epidendraea Fisch.

A. Whole plant ; B. Sepals and petals dissected.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Eulophia ochreata Lindl.

A. Whole Plant ; A^{1}. Upper part of inflorescence scape ; B. Sepals and petals dissected.

3-nerved, somewhat conniving along the column. *Lip* 11-13 mm. long, obscurely 3-lobed, elliptic-orbicular in outline when spread out; sac minute, 1-2 mm. long; lateral lobes 7 × 2 mm., pale cream purplish at the base, erect, conniving over the column; midlobe 4 × 2 mm. yellow, oblong-orbicular, the nerves ending in hairy outgrowths. *Column* 3-4 × 2 mm., subclavate, whitish with a purplish rim just above the small 2 mm. long foot. *Anther* 1.5 × 2 mm., white tinged with purple, orbicular; clinandrium slightly produced behind; pollinia 2, waxy, yellow, 1.5 × 1 mm., globular; caudicle 0.5-0.75 mm. long; gland minute orbicular. *Stigmatic surface* transversely elliptic orbicular, rather large for the column. *Capsules* 28 × 12 mm., broadly ovoid, deflexed, strongly ridged, green; pedicels 5 mm. long, green.

Flowering: June to July. *Fruiting:* August to October.

Occurrence in Bombay State: GUJARAT: Khodwa, in Panch Mahals, *Raoji*. KONKAN: *Stocks*; Salsette, hills east of Tulsi Lake, *McCann*; Borivli, top of Kanheri Caves, *Santapau* 11051; *R. Fernandez* 1840-1841; Mumbra, *Shenoy* 3535, 3556, 3558; *Kapadia* 1263-1268. DECCAN: Purandhar, *Santapau* 7256. W. GHATS: Khandala, *Santapau* 787, 2139. N. KANARA: *Law*; Dharwar, *Law*.

Distribution: Gujarat, Konkan, Deccan, W. Ghats, N. Kanara, Vizagapatam hills at about 1000 metres.

Notes: We have found this species on sloping ground, usually in undergrowth of rather thin forest.

3. **Eulophia herbacea** Lindl. Gen. Sp. Orch. 182, 1833, et in Journ. Linn. Soc. 3: 24, 1858; Dalz. & Gibs. 265; Hook. f. 2; Duthie 123, t. 106, et Fl. Upp. Gang. Pl. 3: 196, 1920; Cooke 693; Gammie 90; Blatt. & McC. 485; Fischer 1435. *Limodorum bicolor* Roxb. Fl. Ind. 3: 469, 1832. *Eulophia carinata* Graham, Cat. Bomb. Pl. 202, 1839, (non Lindl. 1833). *E. bicolor* (Roxb.) Lindl. in Journ. Linn. Soc. 3: 24, 1858 (non Dalz. 1851). *E. brachypetala* Lindl. in Journ. Linn. Soc. 3: 24, 1858. *Graphorchis bicolor* (Roxb.) O. Kuntze, Rev. Gen. Pl. 2: 663, 1891.

Pseudobulbs hypogeal, tuberous, 2-3 cm. in diam., ovoid to broadly conical, with transverse circular markings. *Leaves* 10-30 × 3-9 cm., usually 2-5 per plant, elliptic-lanceolate to broadly elliptic, acute or subacuminate, entire, many-nerved. *Inflorescence* 30-60 cm. tall, erect, arising in the axil of a basal sheath from the pseudostem; peduncles green, terete, with long sheathing bracts. *Bracts* 3.5-5.2 cm. long, pale green, acute to subacuminate. *Flowers* in lax racemes; floral bracts 1-3 × 0.2-0.8 cm., pale green, lanceolate, acuminate, entire, 1-nerved; *pedicel* with *ovary* 1.5-2.5 cm. long, pale green, ribbed. *Sepals* 1.8-2.2 × 0.3-0.5 cm., green, lanceolate, acute, entire, glabrous, 1-nerved. *Petals* 1.5-1.7 × 0.7-1 cm., pure white or white flushed with pale lilac towards the apex, oblong-elliptic, obtuse or subacute, subentire, 1-nerved. *Lip* 1.5-2 cm. long, oblong-elliptic in outline, 3-lobed ; lateral lobes 2 mm. broad, erect, obtuse or acute, white faintly tipped with pale purple ; midlobe 10×9 mm., oblong or obovate-oblong, obtuse, apiculate, pale mauve to deep magenta with white and purple hairy nerves ; occasionally the midlobe is white with light green-yellow, hairy nerves. *Spur* 4 mm. long, footless, white flushed with purple just below the stigma. *Anther* 2×2 mm., 2-celled, light maroon, crowned with a deep maroon spherical process ; pollinia 2, globose-ovate, yellow, attached by a short, thick caudicle to a quadrate gland. *Stigmatic surface* white, just below the clinandrium.

Flowering : July.

Occurrence in Bombay State : GUJARAT : Panch Mahals, *Raoji* ; Khodwa, *Raoji*. KONKAN : *Law*; *Stocks*; *Dalzell*; *Dalzell & Gibson*; Mumbra, *Santapau* 15661-15664; *Shenoy* 3616, 3657-3658; *Kapadia* 1269, 1271-1272 ; Borivli, *Kapadia* 1252. N. KANARA : *Law*.

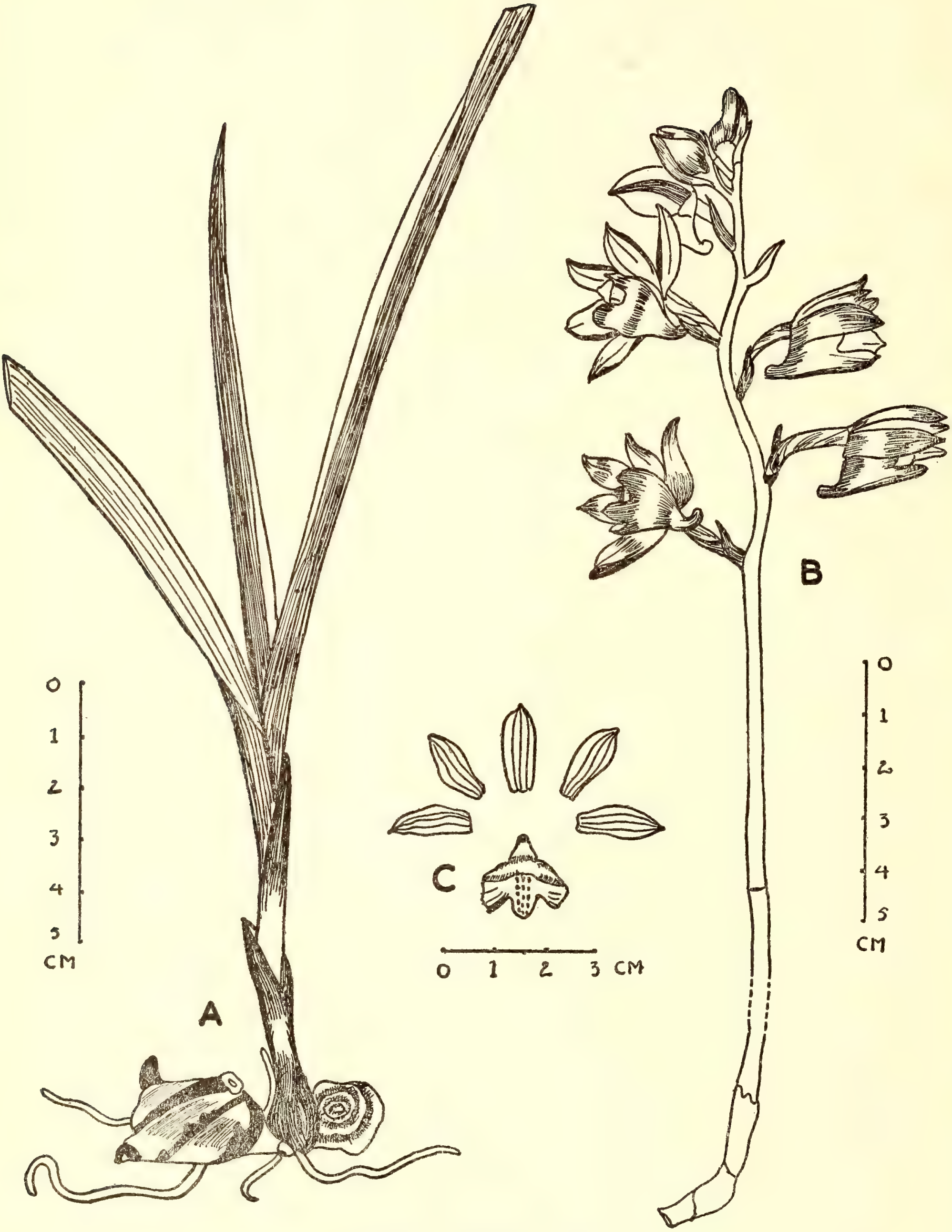
Distribution : W. Himalaya, Garwhal 1300-2300 m., Bengal, Gujarat, Konkan, Kanara, Bababudan hills in Mysore.

Notes: In cultivation the flowers reach a size (up to 4-4.5 cm. across) seldom met with in the field.

This orchid is fairly common together with *E. ochreata* Lindl. on hills at Mumbra. In spite of the fact that they are often found side by side, we have never seen the fruits of *E. herbacea* Lindl., whereas *E. ochreata* Lindl. fruits regularly and abundantly.

4. **Eulophia dabia** (D. Don) Hochr. in Bull. N.Y. Bot. Gard. 6 : 270, 1910. *Bletia dabia* D. Don, Prodr. Fl. Nep. 30, 1825. *Eulophia campestris* Wall. (Cat. 7617, 1832, nom. nud.) ex Lindl. Gen. Sp. Orch. 185, 1833, cum. descr., et in Journ. Linn. Soc. 3: 24, 1858 (excl. syn. *E. ramentacea* Wt.) ; Hook. f. 4 ; King & Pantl. 178, t. 41 ; Duthie 126, et Fl. Upp. Gang. Pl. 3 : 199, 1920 ; Prain 1016 ; Haines 1171 ; Brühl 110 ; Blatt. & McC. 486. *Limodorum ramentaceum* Roxb. (Hort. Beng. 69, 1814, nom. nud. et) Fl. Ind. 3: 467, 1832, cum descr. *Graphorchis dubia* O. Kuntze, Rev. Gen. Pl. 2 : 662, 1891.

Pseudobulbs tuberous, irregular in shape, generally oblong-orbicular, with a few fleshy roots at the junction of the stem. *Scape* leafless, 14-18 cm. tall, erect ; sheaths oblong, acute, somewhat closely appressed, 8-16 mm. long. *Racemes* 5-11 cm. long, lax, subsecund. *Flowers* about 10-12 mm. long, erect, drooping after fertilization. *Bracts* 3-8×3 mm., erect, pale brown, sheathing and membranous, oblong or oblong-lanceolate, acute, entire, 3-nerved. *Pedicel* with *ovary* 10 mm. long, slender. *Sepals* 5-8×2-3 mm., narrowly oblong, acute, entire, 5-nerved, glabrous ; petals similar to sepals but slightly narrower. *Lip* 7-9 mm. long, 3-lobed ; lateral lobes connivent with the column, obtuse, 4-5 mm.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Eulophia ramentacea Lindl.

A. Plant in leaf ; B. Inflorescence scape ; C. Sepals and petals dissected.

long; midlobe 3-4×2-4 mm., orbicular-quadrate, crenulate, rounded, warted above. *Spur* 2 mm. long, narrow, obtuse. *Capsules* 1.8×0.4 cm., oblong-obovate, drooping; stalk 5 mm. long.

Flowering: January (Oudh), April (Bombay).

Occurrence in Bombay State: KONKAN: Bombay, Victoria Gardens, wild, *Hallberg ex Blatter & McCann.* We have seen no specimens from Bombay State.

Distribution: India: Sub-Himalayan tracts of Rohilkhand and N. Oudh, Sikkim, Bengal, Konkan, Deccan. *World*: Afghanistan, Baluchistan, India, Nepal, and Upper Burma.

Notes: There is no doubt that *Bletia Dabia* was intended by D. Don and was not a mistake for *dubia.* This is shown first by the use of an initial capital letter for the specific epithet by Don, and by the reference to *Limodorum Dabia* Ham. MS. O. Kuntze has pointed out that, according to Lindley, who apparently saw the original sheet of Hamilton the specific name should be *dubia*; Hooker f. seems to be of the same opinion, for he cites *Limodorum dubium* Ham. MSS. Whatever may have been the specific name intended by Hamilton, it is quite clear that Don's *Prodromus* gives *Bletia Dabia.* Hochreutiner seems to be correct in using the same specific epithet. Our drawing and description of this species have been done from *Inayat* 24145 from Motipur, Oudh, kindly loaned by the National Herbarium, Calcutta.

5. **Eulophia ramentacea** Lindl. ex Wight, Icon. 5 (1): 8, t. 1666, 1851 (non Lindl. 1858). *E. virens* Graham, Cat. Bomb. Pl. 202, 1839 (non R. Br. 1822). *E. pratensis* Lindl. in Journ. Linn. Soc. 3: 25, 1858; Dalz. & Gibs. 264; Hook. f. 4; Cooke 694; Gammie 90, t. 4; Blatt. & McC. 486; Fyson, Fl. Nilg. Puln. Hill Tops 393, 1915, & t. 513, 1920; Fischer 1435. *Graphorchis pratensis* (Lindl.) O. Kuntze, Rev. Gen. Pl 2: 662, 1891. (See Plate XXVIII).

Pseudobulbs shortly pyramidal or irregularly 3-cornered. *Leaves* 2-4, appearing before the flowers, usually withering at the time of flowering, 11-30×1-2 cm., narrowly oblong-lanceolate, acute. *Scape* 17-48 cm. long, erect, from the top or side of the pseudobulb, 2.5 mm. in diam., terete, 1-2-noded, pale green or at times tinged with purple. *Bracts* unequal, ovate to lanceolate, acute, entire, purplish green. *Flowers* 2.5×3 cm. *Bracts* persistent, 1-1.5×0.3-0.5 cm., equal to or slightly longer than pedicels, oblong or oblong-lanceolate, acute, entire, glabrous, 7-nerved, pale purplish green. *Sepals* and *petals* subequal, pale maroon suffused with varying amounts of yellow, acute, entire, glabrous, faintly 3-5-nerved; sepals spreading, oblong, 1.7-1.8×0.4-0.6 cm., midnerve somewhat prominent below; *petals* 1.6×0.6-0.7 cm., oblong-elliptic, midnerve not prominent below. *Lip* 3-lobed, 13 mm. long, 6-7 mm. broad at the mouth between lateral lobes; lateral lobes 11×6 mm.

erect, light yellow, subfalcately oblong, obtuse; midlobe 6×5 mm., ovate-oblong or suborbicular, mucronulate, entire, yellow; disc of the lip with 3 central, crested, yellow nerves, ending in 3 rows of deep yellow papillae on the midlobe. *Spur* 4-6 mm. long, maroon-yellow, incurved, sharply conical from a broad mouth. *Column* 9×3-4 mm., greenish white, slightly tinged with pale maroon on the dorsal surface, oblong, subclavate, footless and wingless. *Anther* orbicular, white with a maroon apiculum, the anterior lip truncate; pollinia 1×1 mm., oblong-orbicular, posteriorly foveolate, caudicle 1-1.5 mm. long; gland narrow, 2 mm. long, transversely placed. *Stigmatic surface* pale green, oblong-orbicular. *Capsules* 3×1.7 cm., drooping, obovate-oblong, greenish purple with 3 strong longitudinal bands which are about 3 mm. broad; pedicels 1 cm. long, recurved.

Flowering: December to February. *Fruiting:* March.

Occurrence in Bombay State: GUJARAT: Panch Mahals, *Raoji.* KONKAN: Bombay, cultivated, *Kapadia* 1175, 1359. W. GHATS: Panchgani, *Cooke.* DECCAN: Poona, *Woodrow*; Pashan, 6 miles W. of Poona, *Tukaram*; *Paranjpe*; *Gammie*; *Santapau* 6140, 18079-18083; *Kapadia* 1040-1042, 1820-1822. N. KANARA: Belgaum, *Ritchie*; Dharwar, *Bourne*; Havasbavi, in Dharwar Dist., *Sedgwick*; Haveri, *Talbot.*

Distribution: Gujarat, W. Ghats, Deccan, N. Kanara.

Notes: This species has been found among short grasses in clay muddy soil.

While this species is in leaf, it is influenced to a considerable extent by the amount of moisture in the soil. Normally leaves are produced in the monsoon and completely wither off by October, so that at the time of flowering, in the cold season, the plant is completely leafless. On one occasion a single flowering plant was found in marshy, very moist soil with the leaves intact; this may have been due to the abundance of moisture in the soil.

Hooker f. says that ' Lindley and the Bombay Flora err in describing this species as leafless when flowering.' Hooker seems to be incorrect; for *usually* the species is leafless at the time of flowering. It may be that the plants seen by Hooker f. were collected from a very marshy habitat, with the leaves still persistent, as has been observed by us. Wight, loc. cit. 8, states: ' This species is leafless when in flower; as in the case of some others, the leaves follow the flowers.' Wight does not seem to be correct, for the leaves precede the flowers; he is right when he states that the plant is leafless at flowering time.

6. **Eulophia nuda** Lindl. [in Wall. Cat. 7371, 1832, nom. nud. et] Gen. Sp. Orch. 180, 1833; Hook. f. 5, et in Ann. R. Bot. Gard. Calcutta 5: 32, tt. 47-50, 1895; Grant, Orch. Burma 218, 1895; King & Pantl.

180, t. 243; Duthie 127, et Fl. Upp. Gang. Pl. 3 : 200, 1920; Prain 1016; Cooke 695; Gammie 90; Blatt. & McC. 487; Fyson 393, t. 514; Haines 1435; Brühl 109; Fischer 1435. *E. squalida* Lindl. in Bot. Reg. 27 : misc. 77, 1841; J. J. Smith 225, f. 165; Holttum 533, f. 158 (?). *E. bicolor* Dalz. in Kew Journ. Bot. 3 : 343, 1851; Dalz. & Gibs. 264. *Cryptopera fusca* Wight, Icon. 5 (1) : 11, t. 1690, 1891.

Tubers spherical, brownish green, 6 cm. or more in diam. with transverse ridges. *Leaves* from the side of the tuber forming a short pseudostem, from which the inflorescence is given out; 60 × 6 cm., oblong-lanceolate, acute, entire, plicate, many-nerved. *Inflorescence* about 50 cm. tall, the peduncles with a few oblong-lanceolate, many-nerved sheaths. *Flowers* 4.5 cm. across, in lax racemes; *bracts* 2.4 × 0.3 cm., pale yellowish green, lanceolate, acuminate, entire. *Sepals* 2.8 × 0.6 cm., spreading, subequal, deep mauve-brown on the outside, paler and brownish on the inside, faintly yellowish at the tips, lanceolate, acute, entire, many-nerved, the lateral sepals falcate and attached to the foot of the column. *Petals* 2.4 × 0.9 cm., narrow, ovate-oblong, obtuse, entire, many-nerved, lying together over the column only the apices being slightly turned upwards; their colour is white or whitish flushed with rose-purple, the colour more prominent towards the base and on the midnerve. *Lip* 3-lobed, rose-purple, 2.4 cm. long, 1.6 cm. broad across the lateral lobes; lateral lobes erect, small, 3 mm. broad; midlobe oblong, suborbicular, emarginate, crenate, crisped, 12 mm. broad; disc of the lip with 8-10 nerves which become crisped on the midlobe. *Column* 7 × 4 mm., rose-purple, foot 5 mm. long. *Spur* brown-mauve, 6 × 4 mm., projecting below between the 2 arms of the foot, obconical, retuse. *Anther* 4 × 2.5 mm., broadly triangular-conical, mauve, with 2 deep mauve bosses on the anterior face; pollinia 2, ovoid-oblong, yellow, waxy, with a very short caudicle and a small narrow gland. *Ovary* with *pedicel* 2.6 cm. long, twisted, ribbed.

Flowering : June.

Occurrence in Bombay State : KONKAN : Bombay, cultivated. W. GHATS : Ramghat, *Ritchie.* DECCAN : Ambenali, at the foot of Mahableshwar, *Blatter & McCann.* N. KANARA : Londa, *Ahmed Khan*; Kalanaddi, *Ritchie*; Foot of Arbail Ghat, *Sedgwick.*

We have not seen this species in Bombay, our drawing and description are based on *Santapau* 20830-20832 and *S. K. Wagh* 2900-2901, from Andhra State.

Distribution : India : Tropical Himalaya, Sikkim, N. Oudh, Chota Nagpur, Assam, Khasia Hills, southwards to the western parts of the Peninsula, W. Ghats, and Vizagapatam Hills. *World :* India, Nepal, Ceylon, Burma, (?) Malaya, (?) Java, (?) Sumatra, (?) New Guinea, (?) Philippines, and China.

Notes: This species is widely distributed and shows considerable variations both in the size and coloration of the flowers. From Holttum's and J. J. Smith's figures and descriptions of *Eulophia squalida* Lindl., the two species seem to be closely allied ; this similarity has been pointed out by J. J. Smith. Should they be identical, then *nuda* is the earlier valid specific epithet for the combined species.

Hooker f. (in *Ann. R. Bot. Gard. Calcutta* 5 : 32, 1895) distinguishes 4 divergent varieties, which have been based solely on slight colour and size variations ; we consider them merely as forms. Consequently : *E. nuda* f. *nuda,* the typical form, is that of Hooker f. in Ann. R. Bot. Gard. Calcutta 5 : 32, t. 47, 1895.

E. nuda f. *macrantha* (Hook. f.) Sant. & Kapadia, stat. nov. *E. nuda* var. *macrantha* Hook. f. loc. cit. t. 48, 1895.

E. nuda f. *purpurea* (Hook. f.) Sant. & Kapadia, stat. nov. *E. nuda* var. *purpurea* Hook. f. loc. cit. t. 49, 1895.

E. nuda f. *andersonii* (Hook. f.) Sant. & Kapadia, stat. nov. *E. nuda* var. *andersonii* Hook. f. loc. cit. t. 50, 1895.

The specimens from Andhra here described, *E. nuda* as given by Cooke, and *E. squalida* Lindl. given by J. J. Smith and Holttum, clearly belong to f. *purpurea.*

AËRIDES LOUR.

AËRIDES Lour. Fl. Coch. 525, 1790 ; Endl. Gen. Pl. 206, 1837 ; Benth. & Hook. f. Gen. Pl. 3 : 576, 1883 ; Pfitz. in Engl. & Prantl, Pflanzenf. 2 (6): 217, 1889 ; Hook. f. Fl. Brit. Ind. 6 : 43, 1890; King & Pantl. in Ann. R. Bot. Gard. Calcutta 8 : 210, 1898; Duthie, ibid. 9 (2): 142, 1906 ; J. J. Smith, Fl. Buitenz. 6 : 581, 1905 ; Schltr. Orchid. 541, 1927 ; Holttum, Rev. Fl. Malaya 1 : 692, 1953.

The name *Aërides* is derived from the Greek word 'aer' = air, in allusion to the epiphytic nature of the plants and their power of drawing substances from the atmosphere.

Perennial *epiphytes. Stems* fairly long, rarely branching, stout, often sheathed by the bases of fallen leaves. *Leaves* flat or rarely terete, alternate, distichous, spreading, coriaceous, sessile, sheathing at the base. *Inflorescence* in simple or branched panicles, bearing scented flowers. *Sepals* and *petals* similar, spreading ; the lateral sepals often slightly oblique and decurrent on the column-foot. *Lip* sessile, rather stiffly articulated with the column-foot, saccate or spurred at the base, 3-lobed ; lateral lobes small ; midlobe spreading, various. *Spur* usually bent forwards. *Column* short, thick, semiterete, wingless, produced into a stout foot. *Anther* 2-celled, terminal, opercular, incumbent, convex ; pollinia 2, compressed-globose, posteriorly foveolate with long, narrow caudicles and small, somewhat square glands. *Capsules* oblong or clavate, ribbed, the ribs prominent, often narrowly winged.

This is a small genus distributed through India, Indo-China and Malaysia, with a single species in Japan.

The 3 Bombay species belong to *Planifoliae* of Bentham & Hook. f. or to *Euaërides* of Pfitzer. The name of this section must be changed to *Aërides* sect. *Aërides*, according to Art. 22 of the Code, since it contains the type species of the genus, *A. odoratum* Lour.

KEY TO THE SPECIES OF *AËRIDES* OF BOMBAY

1. Midlobe of lip linear-oblong, fleshy, about 7 mm. long, white or pale lilac ; spur about equalling the lip .. .. *ringens*
1. Midlobe of lip broadly obovate or obovate-deltoid, somewhat fleshy, about 14-22 mm. long, deep pink-mauve ; spur about half as long as the lip :
    2. Sepals and petals spotted ; lateral lobes of lip minute, rounded ; midlobe 12-14 mm. long.. *maculosum*
    2. Sepals and petals not spotted ; lateral lobes of lip 7-9 mm. long, narrowly oblong ; midlobe 20-22 mm. long .. .. .. *crispum*

ENUMERATION OF THE SPECIES OF *AËRIDES* OF BOMBAY STATE

1. **Aërides ringens** Fischer in Kew Bull. 284, 1928, et Fl. Pres. Madr. 1442, 1928 ; Blatt. & McC. in Journ. Bombay nat. Hist. Soc. 35 : 490, 1932. *Saccolabium ringens* Lindl. Gen. Sp. Orch. 221, 1833, et in Journ. Linn. Soc. 3 : 36, 1858 (excl. Khasia); Wight, Icon. 3 (2): 10, t. 917, 1844-1845 (non Dalz. & Gibs. 1861). *Aërides radicosum* A. Rich. in Ann. Sc. Nat. ser. 2, 15 : 65, f. 1 c, 1841 ; Dalz. & Gibs. 265 ; Hook. f. 46 ; Cooke 2 : 700, 1907 ; Gammie in Journ. Bombay nat. Hist. Soc. 19 : 141, 1909 ; Fyson, Fl. Nilg. Puln. Hill-Tops 395, t. 249, 1915. *Saccolabium rubrum* Wight, Icon. 5 (1): 9, t. 1673, 1851; Dalz. & Gibs. 264 (non Lindl. 1833). *S. paniculatum* Wight, Icon. 5 (1): 9, t. 1676, 1851. *Aërides lineare* Hook. f. Fl. Brit. Ind. 6 : 47, 1890. (See Plate XXIX).

Epiphytes. Stem 1-1.5 cm. thick, sheathed. *Leaves* 5-21 × 0.3-0.7 cm., coriaceous, channelled, linear or linear-oblong, bilobed at the apex (the lobes unequal, rounded), purplish green very often mottled with deeper-coloured spots. *Racemes* 6-26 cm. long, erect, rigid, often branched ; peduncles 2-3 mm. thick, terete, brown, with oblong sheathing bracts. *Flowers* pedicellate, bracteate, about 1.5 cm. long. *Bracts* 2 × 2 mm., triangular, acute, greenish at the base, scaly and pale brown above. *Sepals* subequal, entire, obtuse, mucronulate, faintly 5-nerved, white tinged with pale mauve-lilac, more so towards the edges ; dorsal sepal 7 × 4 mm., obovate-oblong ; lateral ones 6 × 4 mm., parallel, not spreading, oblong, broader at the base than the dorsal sepal. *Petals* 6 × 3 mm., similar to the sepals in colour, obovate, tapering at the base, obtuse, entire, faintly 5-nerved. *Lip* 10 mm. long, 3-lobed, white or pale lilac with several deeper-coloured longitudinal streaks along the middle ; lateral lobes 3 × 3 mm., erect, triangular-cuneate, obtuse, entire, rarely slightly wavy, with a callus which is 2 × 2 mm., rhomboid-orbicular, bilobed ; midlobe 7 × 4 mm., broadly linear-oblong, inflated about the middle, entire, the apex upturned, retuse or rarely truncate. *Spur* 8 × 2 mm., white, broadly funnel-shaped, incurved, subclavate, obtuse at the apex. *Column* 4 × 2 mm., white, produced below into a foot which is 3 mm. long, somewhat convex and centrally grooved ; rostellum strongly beaked with a central deep groove. *Anther* 2.5 × 2.5 mm., creamy, orbicular with a sharp acute apex ; pollinia 2, yellow, waxy, orbicular-ovate ; caudicle 1.5 mm. long, tapered at the base into an oval gland. *Stigmatic surface* orbicular, white. *Ovary* with *pedicel* 9 mm. long, brownish green. *Capsules* 1.5 × 0.6 cm., obovoid-oblong, strongly ribbed ; pedicels 11 mm. long.

Flowering : March to July. *Fruiting:* July onwards.

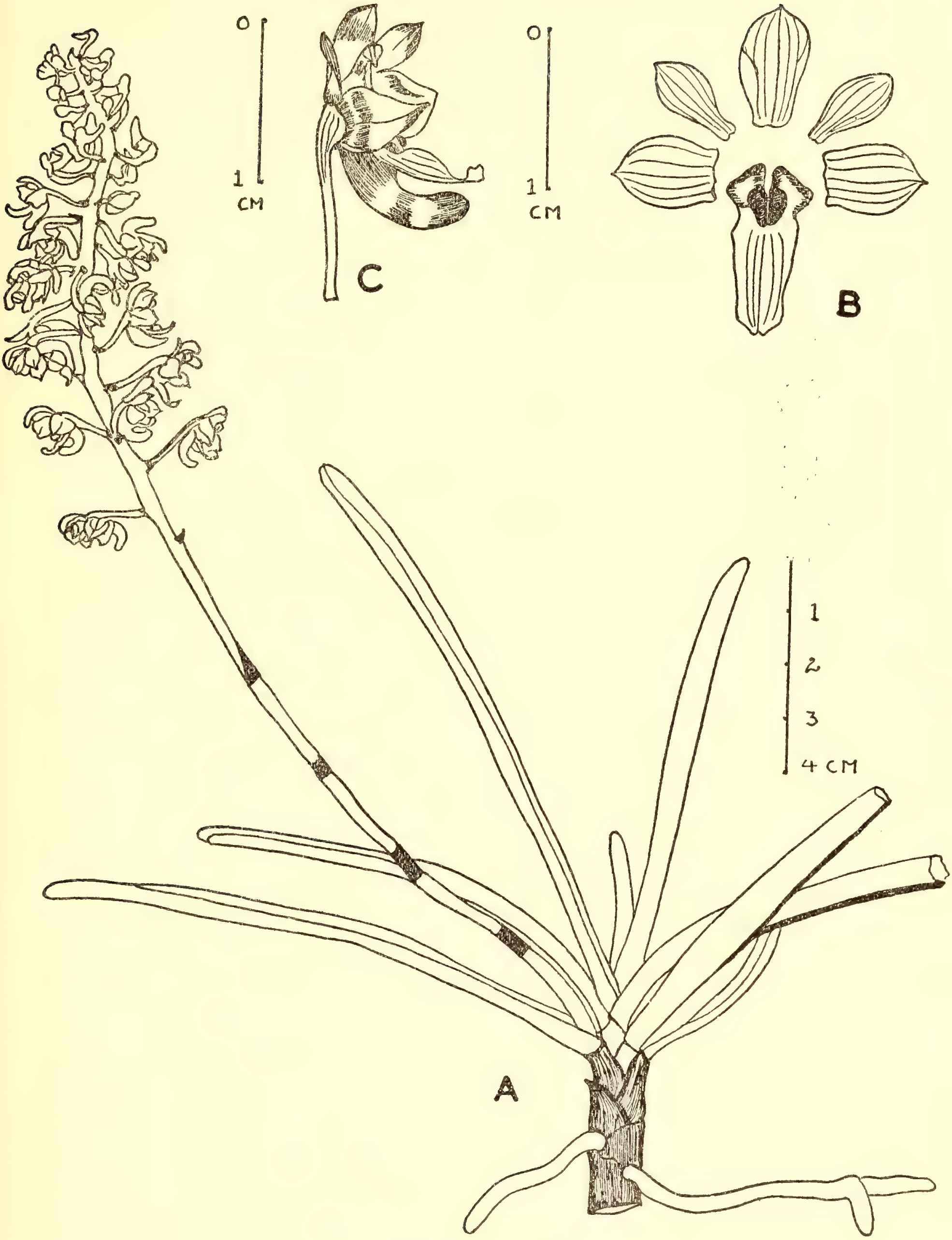
Occurrence in Bombay State : KONKAN : Salsette, *Dalzell & Gibson.* W. GHATS : Mahableshwar, *Woodrow.* N. KANARA : W. of Astoli, *Sedgwick* ; Near Kanappa on the Kalanaddi, *Ritchie* ; Yellapur, *V. Patel* 1846 ; *Kapadia* 1994-1995, 2001, 2320-2322, 2346 ; Kumbelli Mines, about 17 miles from Supa, *Kapadia* 2573-2574; Bhagwati-Yellapur, *Kapadia* ; Jog, *Kapadia* 1854-1855.

Distribution : Konkan, N. Kanara, and the W. Ghats of south India from about 250 to 2500 metres.

Notes : Dalzell & Gibson mention the plant as abundant in Salsette; none of the subsequent collectors have recorded it from Salsette. We have found it common and fairly abundant in N. Kanara.

2. **Aërides maculosum** Lindl. in Bot. Reg. t. 58, 1845, et in Gard. Chron. 691, 1845 ; Dalz. & Gibs. 266 ; Hook. f. 45 ; Prain, Beng. Pl. 1020, 1903 ; Cooke 699 ; Gammie 140, t. 8 ; Haines, Bot. Bih. Or. 1182, 1924; Fischer 1442; Blatt. & McC. 490; Santapau in Rec. Bot. Surv. Ind. 16 (1): 303, 1953 ; Sant. & Kapadia in Journ. Bombay nat. Hist. Soc. 54 (1) : 220, 1956, cum fig. *Saccolabium speciosum* Wight, Icon. 5 (1) : 9, tt. 1674-1675-1851. (See Plate XXX).

Epiphytes. Stem 1-1.5 cm. thick, sheathed. *Leaves* channelled, coriaceous, 3-23 × 2-3 cm., green mottled with purple, linear-oblong or oblong, broadest about the middle, with 2 unequal rounded lobes at the apex. *Inflorescence* up to 24 cm. long, simple or branched ; peduncles terete, stout, sheathed, brownish green mottled with purple. *Flowers*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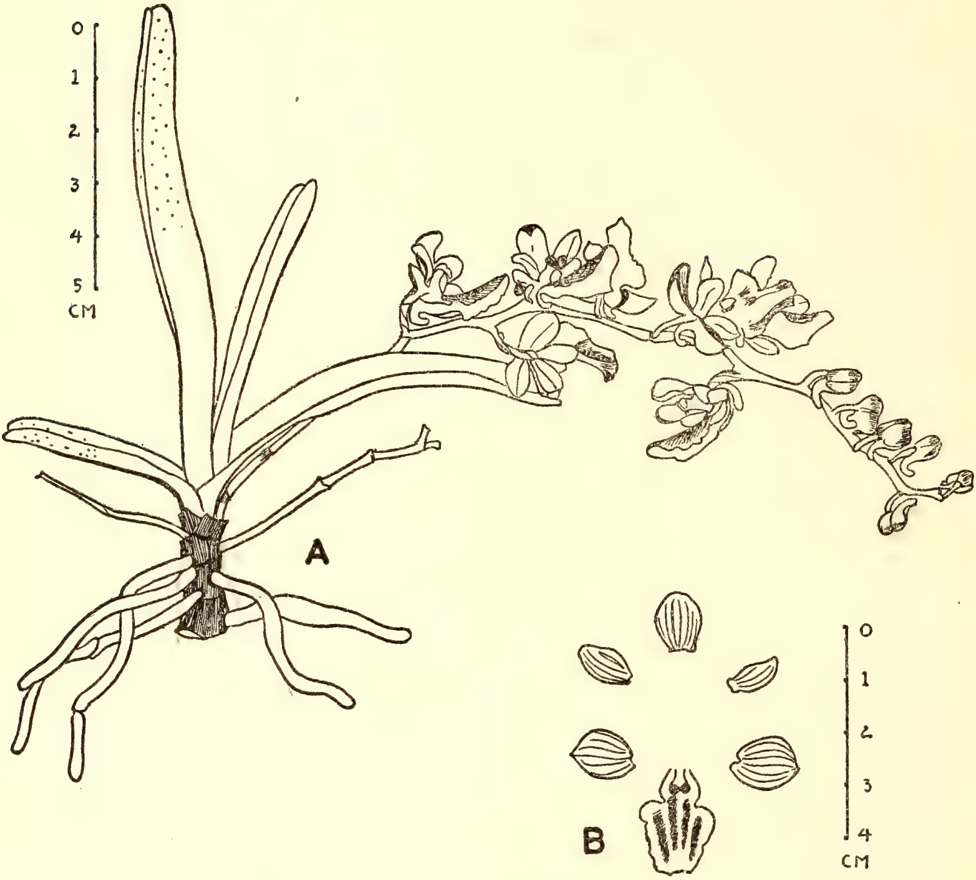
Aërides ringens Fisch.

A. Whole plant ; B. Sepals and petals dissected ; C. Side view of flower.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Aërides maculosum Lindl.

A. Whole Plant ; B. Sepals and petals dissected.

about 2.5 cm. in diam., pedicellate, bracteate, faintly perfumed. *Pedicel* with *ovary* 10 mm. long, pink, ribbed. *Bracts* minute, ovate, acute, entire or rarely subcrenulate. *Sepals* 11 × 8 mm., subequal, obovate-orbicular, obtuse, the lateral ones suboblique, mucronulate, entire, faintly 7-nerved, all white flushed with pink-mauve deeper towards the extremities, usually speckled with darker-coloured spots. *Petals* 10 × 5-6 mm., similar to the sepals in colour, oblong-elliptic, often subfalcate, obtuse or slightly retuse, entire, faintly 7-nerved. *Lip* 20 × 14-15 mm., 3-lobed, straight ; lateral lobes small, about 2-3 mm. broad, spreading, faintly pinkish white, rounded, with a fleshy white subconical bilobed callus in between ; midlobe 14 × 14 mm., deep rose-pink flushed with mauve, obcuneately quadrate, obtuse or truncate, rarely retuse, irregularly crenate and finely crisped on the margins, the upper surface with parallel ridges from the callus deflexing the sides and the apical portion of the midlobe. *Spur* 5 mm. long, curved downwards, hook-like, somewhat tapering to an obtuse subclavate greenish apex ; the mouth broad, formed by the backward continuation of the lip and the foot. *Column* 5 × 2 mm., pink, oblong, slightly upturned above, produced below into a 2-4 mm. long, stout foot ; clinandrium pale pink with 2 short deeper-coloured streaks and a central ridge. *Anther* 3 × 3.5 mm., obovate-orbicular, pink, the anterior lip truncate ; pollinia 2, each 1 × 1.5 mm., waxy, yellow, broader than long, with a 2 mm. long caudicle and narrow elliptic gland. *Stigmatic surface* 4 × 3 mm., oblong-orbicular. *Capsules* 3-5 × 0.8-1 cm., obovoid, strongly ribbed, shortly stalked.

Flowering : May to June. *Fruiting :* July onwards.

Occurrence in Bombay State: KONKAN: Badlapur, *Kapadia* 1946, 1947, 1948-1949 ; Karjat, *Kapadia* 1956 ; Tansa, *Kapadia.* W. GHATS : Khandala, *Hallberg* ; *Santapau* 417, 417A, 498, 506, 2049, 2191, 2441, 4482, 9008, 9048, 9120-9122, 11033-11034, 27962, 28605 ; *Kapadia* 494, 1173-1174, 1943-1944 ; Lonavla, *Garade* ; *Kapadia* 1122 ; Panchgani, *Cooke* ; *Alice Pigott* ; *Kapadia* ; Mahableshwar, *Cooke* ; *Kapadia.* DECCAN : Purandhar, *Santapau* ; *Kapadia* 645 ; Bhimashankar, *Kapadia* 1446. N. KANARA : Belgaum, *Ritchie* ; *Kapadia* ; Sirsi, *Hallberg & McCann* 34968 ; Belgaum-Khanapur, *Kapadia* ; Castle Rock, *Kapadia.*

Distribution : Chota Nagpur, Konkan, Deccan, N. Kanara, and W. Ghats of south India up to 1400 m.

Notes : This is one of the commoner epiphytic orchids in more or less open deciduous forests. It has been noted on various trees, among them *Terminalia crenulata* Roth being one of the more frequent.

3. **Aërides crispum** Lindl. [in Wall. Cat. 7319, 1832, nom. nud.] Gen. Sp. Orch. 239, 1833, cum descr.; Bot. Reg. t. 55, 1841 ; Gard. Chron. 711, 1842 ; et in Journ. Linn. Soc. 3 : 41, 1858 ; Dalz. & Gibs,

265 ; Hook. f. 45 ; Grant, Orch. Burma 268, 1895 ; Cooke 700 ; Gammie 139 ; Fyson 394, t. 248 ; Fischer 1442 ; Blatt. & McC. 490 ; Santapau 303. *A. lindleyana* Wight, Icon. 5 (1): 9, t. 1677 bis, 1851; Lindl. in Journ. Linn. Soc. 3 : 41, 1858 ; Dalz. & Gibs. 265.

Epiphytes. Stems 1-2 cm. thick, sheathed. *Leaves* 7-24 × 1.6-3 cm., thickly coriaceous, rarely channelled, oblong, pale green with a purplish tinge at the base, with 2 unequal rounded lobes at the apex. *Inflorescence* 10-30 cm. long, erect or drooping, rarely branched ; peduncles 2-4 mm. thick, brown with a few small closely appressed sheaths. *Flowers* about 3 cm. across, bracteate, pedicellate, strongly and sweetly scented especially when fresh. *Bracts* 5 × 5 mm., semi-amplexicaul, triangular-ovate, acute, entire, scabrid, brown, 3-nerved. *Pedicel* with *ovary* 1.7 cm. long, straight or slightly curved, faintly ribbed, rose-pink. *Sepals* spreading, minutely denticulate, acute-mucronulate, glabrous, faintly 9-nerved ; lateral sepals 16 × 12 mm., obliquely oblong, pinkish white tinged with mauve towards the apex, more so on the back ; dorsal one 15 × 10 mm., oblong-suborbicular, pinkish white with a broad, mauve patch on the back. *Petals* 16 × 10 mm., spreading in the same plane as the sepals, obovate-orbicular, rarely suboblique, acute-mucronulate, minutely denticulate, faintly 7-nerved. *Lip* 28 mm. long, 3-lobed, very shortly clawed, somewhat geniculately inflexed at the claw ; lateral lobes 5 × 3-4 mm., oblong, obtuse, entire or slightly crenulate, more or less spreading, but erect at the base, with a somewhat square hollow which leads to the spur ; the entrance to the spur being somewhat arched over by 2 fleshy, pinkish white subconical calli, lying back to back with their apices diverging ; midlobe 22 × 20 mm., pink-mauve, deeper than the sepals and petals, broadly ovate, 5-7 mm. broad at the apex, retuse ; margins deflexed, finely crisped, crenulate. *Spur* 10 × 4 mm., inflexed from below the lateral lobes, proceeding under the midlobe, obtuse, pale mauve-pink. *Column* 6 × 5 mm., oblong, subclavate, produced at right angles into a 10 × 6 mm. obcuneate-oblong foot, on which the lip somewhat articulates. *Anther* 6 × 5 mm., oblong with 2 mm. long beak, pale yellow with a purple ring round the margins ; pollinia 2, yellow, waxy, globose ; caudicle 3 mm. long, and ensheathed by a gland 2 mm. long. *Stigmatic surface* 4 × 2 mm., elliptic-orbicular. *Capsules* 3-3.5 cm. long, oblong-elliptic, strongly ridged ; pedicels about 1.5 cm. long, slightly curved.

Flowering : May to June. *Fruiting :* July onwards.

Occurrence in Bombay State : KONKAN: Vengurla, *Dalzell & Gibson* ; Wari Country, *Dalzell & Gibson.* W. GHATS : Khandala, *Blatt. Herb.* 27968 ; *Hallberg* ; *Santapau* 8910, 10169, 11032, 12793, 12933 ; Panchgani, *Blatter* ; Mahableshwar, *Blatter*; *Ezekiel* ; *Acland* 1179 ; *Bole* 1045 ; *Kapadia* 1201, 1203, 1212. DECCAN : Bhimashankar, *Kapadia* 1445 ; Koina nagar, *Kapadia.*

N. KANARA: Devarayi, *Sedgwick*; Yellapur, *Bell*; Anmod, *Kapadia*; Castle Rock, *Kapadia*; Poutelli-Dandelli, *Kapadia* 2768-2770; Sampkhand, *Hallberg & McCann* 34204.

Distribution: India: Konkan, W. Ghats, Deccan, N. Kanara, Nilgiri and Pulney Hills at about 800 to 1200 m. *World*: India; probably also found in Burma and Ceylon according to Holttum (*Rev. Fl. Malaya* 695, 1953).

Notes: This species can be easily differentiated from *A. maculosum* Lindl. by the following characters: (1) the whole plant is much stouter and more robust; (2) the flowers are larger; sepals and petals not at all or very sparsely speckled; (3) the lip is more triangular in shape, geniculately inflexed at the claw; (4) the spur is exactly below the lip, not along the ovary. In our experience, however, *A. crispum* seems to be not only scarce, but even on the verge of extinction at least in such places as Khandala and Mahableshwar. The showy flowers and their strong perfume may be put down as the causes for the present shortage of specimens.

Compositae of Dharwar and its Vicinity[1]

BY

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INTRODUCTION

Cooke, Woodrow, Sedgwick, Blatter, Ritchie, Dalzell, and others collected plants from the Dharwar area during the end of the last century and the beginning of the present century. The collections of Sedgwick and Blatter were deposited in the Blatter Herbarium, St. Xavier's College, Bombay, and the collections of the others were housed in the Agriculture College herbarium, Poona (now with the Botanical Survey of India, Western Circle, Poona). Comparatively few species are recorded from Dharwar proper, probably because greater attention has been given to the forest flora of the rich forest zones in the adjoining districts of Belgaum and Karwar. Santapau and his students are carrying out intensive floristic surveys in selected areas of the Bombay State, while the staff of the Botanical Survey of India, Western Circle, is collecting data from different areas. So far as work on the family Compositae is concerned, Santapau (1946) has published an artificial key to the Compositae of the Bombay Presidency (Dharwar formed a part of Bombay State before the States Reorganization in 1956). Venkatesh (1948) devised a key to the Compositae of Bangalore and included 45 species of 39 genera (including the genera *Guizotia* and *Carthamus*). Govindu (1948), ' Some of the Compositae of Bangalore and their economic importance', has described many cultivated and wild species in brief and has given their economic importance. Ladwa (1949), in an account of the ecology of aquatic flora of Dharwar tanks, has recorded the occurrence of a few Composites growing around the freshwater tanks. Since Dharwar is the seat of the Karnatak University and a number of Colleges, it was felt that a detailed survey of the Compositae growing in and around Dharwar will enable students of Botany to know more about this group. The authors are not aware of any work dealing with the Compositae of Dharwar and its vicinity. The present paper deals with a survey of the Compositae growing in and around Dharwar with brief ecological notes on their habitats. An artificial key based on more obvious and reliable characters is attempted for the use of beginners in this field.

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[1] Communicated by the Principal, Karnatak Science College, Dharwar.

LOCATION AND TOPOGRAPHY

Dharwar city (lat. 15° 28′ N. and long. 75° 0′ E.) is situated on the eastern fringe of the Western Ghats at an altitude of 2480 ft. (*c.* 855 m.) above mean sea-level. The western and south-western parts of Dharwar form an undulating hilly tract and the soil is red to greyish brown, chiefly derived from the underlying metamorphosed rocks of the Dharwar System. The eastern part borders the plain and the soil varies from red loams to black-cotton soils. Dharwar is thus situated between a plain on the east and the escarpments of the Western Ghats on the west-south-west. The general nature of the vegetation is the scrub type normally found in deciduous forest under the influence of intense biotic disturbance. The typical dry deciduous forests are found within a range of 10-15 miles west-south-west of Dharwar. The eastern plain is chiefly under cultivation. Dharwar receives a mean annual rainfall of 35 inches (*c.* 89 cm.) mostly falling during the months of June, July, August, and September. It also enjoys a fairly equable climate with gentle fluctuations in temperature.

METHODS

The plants have been collected from Dharwar and its surrounding area within a radius of about 4 miles (*c.* 6 km.). The collections were made during the period from June 1957 to January 1959 by periodical visits to different localities, namely Hattikolla, Nuggikeri, Someshwar, Hubli Road, Saptapur, Amminbhavi Road, Belgaum Road, the University Campus, the Agriculture College, etc. Field notes about the habit and habitat of plants were made on the spot. The identifications have been confirmed after a careful comparison of these herbarium sheets with those in St. Xavier's College, Bombay, and in the Botanical Survey of India, Western Circle, Poona.

Herbarium sheets of all the representative specimens collected from the different localities were prepared, numbered, and deposited in the herbarium of the Botany Department of the Karnatak Science College, Dharwar.

The local names of the plants, wherever available, are given.

Cultivated plants like *Guizotia*, *Carthamus*, *Cosmos*, *Helianthus*, *Zinnia*, *Calendula*, *Tagetes*, *Helichrysum*, *Calliopsis*, *Gaillardia*, *Aster*, *Arctotis*, *Artemisia*, *Coreopsis*, *Tithonia*, *Dahlia*, *Chrysanthemum*, *Centaurea*, etc. are not dealt with here, as they have not truly run wild and they are too well known to be mentioned here.

The Artificial Key for the genera dealt with is based mainly on such characters as the head (heterogamous or homogamous etc.), characters of the leaves, achenes, and pappus. Two genera, viz. *Caesulia* and *Spilanthes*, occur twice in the key, as the former has heads which can be taken as simple or compound and the latter has heads where all flowers are bisexual or the outermost flowers are ligulate and female.

Artificial Key to the Genera of Compositae found in Dharwar

1. Heads compound (formed by the aggregation of smaller heads),
2. Heads spinous .. .. *Echinops*
2. Heads not spinous,
3. Compound head distinctly globose, stem winged .. *Sphaeranthus*
3. Compound heads not globose,
4. Heads rounded at the base, subtended by 3-nervate leaves, flowers yellow .. .. .. *Flaveria*
4. Heads not surrounded by foliage leaves, flowers white or purple,
5. Each head in the compound head 4-flowered, leaves radical and cauline, sessile .. .. *Elephantopus*
5. Each head in the compound head 1-flowered, leaves cauline and petiolate .. .. .. *Lagascea*
5. Each head in the compound head 5-10-flowered, leaves cauline and subsessile .. .. *Blepharispermum*
1. Heads simple (florets within the head not aggregated into smaller heads),
6. Flowers homogamous (all of the same sex), disciform (all tubular, not ligulate),
7. Involucral bracts aristate-acuminate .. .. *Tricholepis*
7. Involucral bracts otherwise,
8. Involucral bracts 2, large & membranous .. *Caesulia*
8. Involucral bracts numerous, in many series .. *Vernonia*
8. Involucral bracts many, in 1-3 series,
9. Pappus 0 or of 2 stiff hairs,
10. Heads small, upto 0.5 cm. in diam., flowers purple.. *Cyathocline*
10. Heads large, more than 1 cm. in diam., flowers yellow *Spilanthes*
9. Pappus of 4-5 aristate scales .. .. *Ageratum*
9. Pappus hairy, pappus hairs many,
11. Slender herb, heads less than 1.5 by 0.5 cm., achenes 5-ribbed, hairy on the ribs .. .. *Emilia*
11. Robust herb, heads more than 1.7 by 0.7 cm., achenes 10 or more ribbed, hairy between the ribs .. *Gynura*
6. Flowers heterogamous (of 2 sexes), peripheral flowers ligulate, others tubular,
12. Leaves pinnately compound or divided,
13. Pappus 0 or of few scales, flowers white .. *Parthenium*
13. Pappus copious, hairy, flowers yellow .. .. *Senecio*
13. Pappus awned, awns 2-4 in number,
14. Achenes densely hairy .. .. .. *Glossocardia*
14. Achenes glabrous,

15. Leaves cauline and opposite .. .. .. *Bidens*
15. Leaves radical, cauline leaves alternate .. .. *Glossogyne*
12. Leaves neither pinnately compound nor pinnately divided,
16. Anther-bases tailed .. .. .. *Vicoa*
16. Anther-bases not tailed,
17. Achenes completely enclosed in boat-shaped stiff paleae .. .. *Sclerocarpus*
17. Achenes not enclosed in the palea,
18. Pappus hairy, hairs copious, palea 0 .. .. *Erigeron*
18. Pappus not hairy; if hairy, hairs few and stiff, palea present or 0,
19. Flowers all white .. .. .. *Eclipta*
19. Flowers all, or the disc only, yellow
20. Leaves all opposite and 3-nervate,
21. Pappus of 2 long awns .. .. .. *Synedrella*
21. Pappus of fimbriate scales .. .. .. *Galinsoga*
20. Leaves all opposite and penninerved,
22. Pappus paleaceous, aristate with feathery bristles, prostrate herb .. .. *Tridax*
22. Pappus spinous, one straight and other hooked, erect herb .. .. *Acanthospermum*
20. Leaves opposite at the base, alternate at the top, pappus of few unequal, short scales .. .. *Blainvillea*
6. Flowers heterogamous, disciform (all tubular),
23. Stem winged, leaves decurrent .. .. *Laggera*
23. Stem not winged, leaves not decurrent,
24. Leaves pinnatifid .. .. *Grangea*
24. Leaves not pinnatifid,
25. Anther-bases subentire, not tailed .. .. *Erigeron*
25. Anther-bases tailed,
26. Style arms of bisexual flower truncate, small herbs .. *Gnaphalium*
26. Style arms of bisexual flower filiform, never truncate, herbs or shrubs,
27. Style of bisexual flower 2-fid, small or large herbs .. *Blumea*
27. Style of bisexual flower entire or 2-3-fid, bisexual flowers sterile, shrubs .. .. .. *Pluchea*
6. Flowers homogamous, all flowers rayed,
28. Achenes compressed, not beaked .. .. *Sonchus*
28. Achenes columnar, truncate at both ends .. *Launaea*
1. Heads simple, monoecious, bisexual and female flowers borne separately in different heads .. *Xanthium*

SYSTEMATIC ENUMERATION[1]

1. Vernonia Schreb.

Vernonia cinerea Less. Local name : Sahadevi.

Commonest weed on all types of soils except in most clay. Weed in fields and gardens. One of the pioneers in inhabiting newly exposed soils. Flowering : August-April.

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[1] Species which are a new record for the locality are marked with an asterisk,

Vernonia anthelmintica Willd. Local name : Kadu jirige, Kare jirige.

On black and red soils. Common in fields of dry crop cultivation. Flowering : October-December.

2. ELEPHANTOPUS Linn.

***Elephantopus scaber** Linn.

Cooke (1904) gives the height of the plant as 6-15 in. (*c.* 15-38 cm.), while specimens from Dharwar attain a height of 6-36 in. (*c.* 15-91 cm.).

Common under guava plantation in Hattikolla, Kyarkopp, Saptapur, Haliyal Road ; under shade of trees, and preferring moist soil. Flowering : August-October.

3. AGERATUM Linn.

Ageratum conyzoides Linn.

A very common weed, quite aggressive and spreading during rainy season and winter, specially in gardens and fields on the roadside. Flowering : October-January.

4. CYATHOCLINE Cass.

Cyathocline purpurea (Don) Kuntze. Syn. *C. lyrata* Cass.

The anther-bases in Dharwar specimens are shortly sagittate or truncate, but Cooke (1904) reports them as truncate.

Abundant as weed in paddy fields after harvest ; often growing with *Sphaeranthus* and *Grangea* ; also on margins of tanks. Indicator of periodically inundated soils. Flowering : December-April.

5. GRANGEA Adans.

Grangea maderaspatana Poir.

On margins of tanks and often abundant in paddy fields after harvest. Fairly common on periodically inundated soils. Flowering : July-September and December-April.

6. ERIGERON Linn.

Erigeron asteroides Roxb.

A common herb found on all types of moist and well-aerated soils, such as raised bunds of tanks, edges of paddy fields, gardens, etc. Flowering : August-February.

***Erigeron bonariensis** L. Syn. *Conyza ambigua* DC., *C. bonariensis* (*L.*) Cronquist.

A common weed of red soils preferring moderately moist types. Often found in gardens. Flowering : July-April.

***Erigeron floribundus** (H.B.K.) Sch. Bip. Syn. *Conyza floribunda* H.B.K., *C. albida* Willd., *Erigeron sumatrensis* Retz.

It was only noticed in the Karnatak University Campus. It seems to prefer moist, red and aerated soils. It is a new record for India (Ladwa & Patil, 1959). Flowering : August-April.

7. BLUMEA DC.

***Blumea wightiana** DC.

Rather rare in Dharwar. Found as a weed in the compounds and the campus of the Karnatak University and Karnatak College, and in paddy fields at Someshwar. Flowering : December-March.

Blumea lacera DC.

Widespread weed on all types of soils and seems to have a wide range of tolerance; on waste places and in brick and mortar waste. A good coloniser. Flowering: November-March.

Blumea oxyodonta DC.

Common hardy plant on moderately moist and porous soils of Hattikolla Hills, pastures, and in gardens. Flowering: November-March.

***Blumea eriantha** DC.

Found in gardens, pastures, roadside fields and paddy fields after harvest as one of the common weeds. Flowering: December-March.

Blumea membranacea DC.

Found on red soils only at Someshwar and Saptapur. Flowering: November-April.

8. LAGGERA Sch. Bip.

***Laggera alata** Sch. Bip.

Localised to the sides of the railway line between Dharwar Station and Navalur Gate. Flowering: November-March.

9. PLUCHEA Cass.

***Pluchea tomentosa** DC.

Localised to the Fort area and the sides of gutters leading from Vidyaranya High School to Haveripeth. Flowering: November-February.

10. SPHAERANTHUS Linn.

Sphaeranthus indicus Linn.

Indicator of periodically inundated soils, growing in close association with *Cyathocline* in harvested paddy fields, dried-up tanks, etc. Flowering: November-April.

11. BLEPHARISPERMUM Wight

Blepharispermum subsessile DC.

Cooke (1904) mentions 'involucral bracts 1-2, like the palea of the receptacle but shorter'. In the specimens collected here, they are found to be as long or longer than the palea. Localised to the hills of Hattikolla and comes up in the rainy season. Flowering: August-September.

12. GNAPHALIUM Linn.

Gnaphalium indicum L.

Grows twice in a year, once at the beginning of the rainy season and again in winter. Common in gardens, tanks, paddy fields. A typical dry-marsh plant.

13. VICOA Cass.

Vicoa indica (Willd.) DC. Syn. *Vicoa auriculata* Cass.

Habit various; stout and tall in good garden soil, black-cotton soil, and agricultural soil, but stunted and unbranched in dry gravelly soils. Flowering: October-February.

14. CAESULIA Roxb.

Caesulia axillaris Roxb.

Grows in red and black-cotton fields with moist soils. Common in paddy fields after harvest. Flowering : October-January.

15. LAGASCEA Cav.

Lagascea mollis Cav.

Weed on roadsides, fields, and gardens. Grows during rainy season and dies after winter. Flowering : August-December.

16. XANTHIUM Linn.

Xanthium strumarium Linn.

Not common. Recorded from Someshwar, Hebballi Farm, and Agriculture College area. Mostly in low-lying areas where water stagnates for a short period. Flowering : October-December.

17. ECLIPTA Linn.

Eclipta prostrata Linn. Syn. *Eclipta erecta* L., *Eclipta alba* (L.) Hask. Local name : Kadiggaraga.

A plant of moist habitat, most common at Dharwar. Grows prostrate near aquatic situations and erect in comparatively dry places. Flowering : August-November.

18. SCLEROCARPUS Jacq.

***Sclerocarpus africanus** Jacq.

Under mango trees in Someshwar only. Flowering : August-October.

19. BLAINVILLEA Cass.

Blainvillea rhomboidea Cass. Local name : Kudda gurellu.

Common weed growing in association with *Lagascea*, *Acanthospermum*, *Galinsoga*, etc. in both red and black soils. Also in gardens. Flowering : August-October.

20. SPILANTHES Linn.

Spilanthes acmella Murr. var. **acmella** proper. Local name : Hemmugulu.

Prefers moist soils, on edges of cultivated fields, ponds, and along waterways. Flowering : September-January.

Spilanthes acmella Murr. var. **oleracea** Clarke

As above but more robust and succulent ; leaves and heads larger. Often cultivated in gardens or grows as an escape. Flowering : September-January.

21. GLOSSOCARDIA Cass.

***Glossocardia linearifolia** Cass.

Commonly found on dry sandy or gravelly soils on Hattikolla Hills and also overgrazed pastures. Flowering : August-December.

22. BIDENS Linn.

Bidens biternata (Lour.) Merr. & Sherff. Syn. *Coreopsis biternata* Lour., *Bidens wallichii* DC., *Bidens pilosa* Auctor.

Common on old roofs, compound walls, roadside fields, in gardens ; usually preferring dry situations. Flowering : September-January.

23. GLOSSOGYNE Cass.

Glossogyne pinnatifida DC.

In overgrazed pastures, dry areas of Hattikolla, and in other areas where the soil is loose and sandy. Flowering : August-April.

24. SYNEDRELLA Gaertn.

***Synedrella nodiflora** Gaertn.

Often growing in association with *Blainvillea*, *Bidens*, *Flaveria*, *Acanthospermum*, *Galinsoga*, etc. Common in waste areas. Flowering : August-December.

25. GALINSOGA Ruiz et Pav.

***Galinsoga parviflora** Cav.

Weed occurring in red soil areas of Dharwar particularly on moist and porous soils. Flowering : August-February.

26. TRIDAX Linn.

Tridax procumbens Linn. Local name : Tikki kasa, Tikki toppala, Gayad toppala.

A weed of cosmopolitan habitat and a very variable habit. Flowering : All the year round.

27. FLAVERIA Juss.

***Flaveria contrayerba** Pers. Local name : Wonti kasa.

Irregularly distributed weed growing on both red and black soils. Flowering : August-March.

28. ACANTHOSPERMUM Schrank.

***Acanthospermum hispidum** DC.

A weed of open waste lands and uncultivated fields and gardens. Flowering : August-March.

29. PARTHENIUM Linn.

***Parthenium hysterophorus** L.

A rare weed of a localised habitat ; is showing a tendency to spread slowly. It seems to be a very recent introduction in this area. Flowering : September-February.

30. GYNURA Cass.

***Gynura angulosa** DC. Syn. *Gynura simplex* D. & G.

Cooke (1904) mentions the pappus as shorter than the corolla but it is invariably as long as the corolla in the specimens collected here. A weed in moist and porous soil and also in cultivated red and black-cotton soils. Flowering : September-January.

31. Emilia Cass.

Emilia sonchifolia (Linn.) DC.

Weed found on all types of soils except those too moist and clayey. One of the pioneers in occupying fresh excavated soil. Flowering : All the year round except May and June.

32. Senecio Linn.

***Senecio tenuifolius** Burm.

Common on the hills of Hattikolla during the late rainy season and early winter on sandy or murram soils. Flowering : August-December.

33. Echinops Linn.

Echinops echinatus Roxb.

A common xerophyte of dry, rocky, or gravelly waste places. Also along the railway line. Flowering : October-April.

34. Tricholepis DC.

Tricholepis glaberrima DC.

A weed of the red and black soils. Very variable in habit. Grows only a few cm. high where the soil is dry and sandy, but reaches 2-3 m. high in cultivated soils. Flowering : November-December.

***Tricholepis radicans** DC.

Only found on dry hillocks of Dharwar. Flowering : November-January.

35. Sonchus Linn.

Sonchus oleraceus Linn.

A very common weed in cultivated fields and waste places in gardens. Flowering : July-February.

36. Launaea Cass.

Launaea nudicaulis Hook.

Common in dry pastures and as a weed on bunds and grassy patches in cultivated areas. Flowering : during summer.

Ecological Observations

The family Compositae has been described by Good (1947) as a cosmopolitan family. Plants like *Vernonia cinerea, Emilia sonchifolia, Tridax procumbens, Ageratum conyzoides, Erigeron bonariensis,* etc. were found growing in moist as well as dry soils and they showed a fairly wide and uniform distribution in this tract. It may be suggested that they have a wide range of tolerance to edaphic, topographic, and biotic factors. Besides, they are more or less aggressive and mobile species also, as they soon occupy fresh situations caused by digging, scraping, etc.

Some plants of the Compositae show distinct preference for certain habitats and thus act as plant-indicators. These habitats may be grossly classified as under on the basis of the nature and type of soil:

(*a*) Periodically inundated soils subject to alternate and seasonal wetting and drying such as the paddy fields, drying tanks, sides of water-courses, low-lying lands, etc. Such areas are inhabited by *Cyathocline purpurea, Erigeron asteroides, Sphaeranthus indicus, Gnaphalium indicum, Grangea madaraspatana, Eclipta prostrata, Caesulia axillaris*, etc.

(*b*) Porous soils often containing sufficient moisture like those of cultivated fields, gardens, moist grass lands, and scrub areas in shallow pans are covered with *Flaveria* sp., *Blumea eriantha, Elephantopus scaber, Caesulia axillaris, Erigeron floribundus, Erigeron bonariensis, Spilanthes acmella, Sonchus oleraceus*, etc.

(*c*) Fairly dry, sandy, or gravelly porous soils, as the exposed sides of hills, excavated areas, etc., are occupied by *Blumea oxyodonta, Glossocardia linearifolia, Glossogyne pinnatifida, Senecio tenuifolius, Emilia sonchifolia, Tridax procumbens, Echinops echinatus, Launaea nudicaulis, Xanthium strumarium, Bidens biternata, Lagascea mollis, Acanthospermum hispidum, Synedrella nodiflora*, etc.

(*d*) Black-cotton soils (which are rich in clay and calcium carbonate) having a higher water-holding capacity generally afford a good habitat for *Blumea oxyodonta, B. eriantha, Caesulia axillaris, Vicoa indica, Tricholepis glaberrima, Sonchus oleraceus, Flaveria contrayerba, Blainvillea rhomboidea, Vernonia cinerea, V. anthelmintica*, etc. It should, however, be noted that none of the above species is exclusively restricted to the black-cotton soils.

(*e*) Fallow open ground, waste lands in the vicinity of human habitation, roadside fields, and fallow areas in gardens are occupied by *Vernonia cinerea, Blumea* spp., *Tridax procumbens, Lagascea mollis, Ageratum conyzoides, Acanthospermum hispidum, Erigeron bonariensis*, etc.

Sclerocarpus africanus is very much localised to the mango grove at Someshwar, while *Laggera alata* was observed only on the gentle slopes of the railway line embankments towards Hubli. Similarly, *Blepharispermum subsessile* is found on the eastern slopes of Chotamahabaleshwar Hill.

A few of the Composites show remarkable variations in their habits. *Eclipta prostrata* grows as a prostrate herb when it is close to aquatic situations, but otherwise it grows as an erect herb. *Vernonia cinerea* grows as an erect herb 30 cm. high during the monsoons while, in the same area and in the middle of summer, the flowering specimens of this plant are hardly 6 cm. high. The same could be said of *Erigeron bonariensis, Tridax procumbens, Bidens biternata, Tricholepis glaberrima, Ageratum conyzoides, Acanthospermum hispidum, Launaea nudicaulis,* etc. This clearly explains their wide range of tolerance to changing climatic or edaphic conditions.

DISCUSSION

Santapau (1946) published an artificial key to 51 genera of the Composites of the Bombay Presidency. He based his classification of genera on the colour character of flowers, which is so often not constant and is not reliable particularly in the case of herbarium material. In the present work, an artificial key to the genera is given so as to enable an average student to recognise the Compositae of Dharwar. In this key, importance is given to the characters of the head.

The earlier work of Cooke (1904) describes only 11 species as occurring in Dharwar-Hubli area, while as many as 32 species have been described for Belgaum, a place 45 miles north-west of Dharwar. However, such genera as *Elephantopus, Laggera, Pluchea, Sclerocarpus, Glossocardia, Galinsoga, Synedrella, Gynura, Senecio, Acanthospermum, Parthenium,* and *Flaveria* have not been mentioned for this area. New records of species for this locality number as many as 18 and are denoted by an asterisk in the systematic enumeration. This large number of new records does not include species whose distribution is given as ' throughout India ', ' abundant in Bombay Presidency ', and ' common in the Deccan '. It may also be mentioned here that genera like *Parthenium, Synedrella, Galinsoga, Acanthospermum,* and species like *Erigeron bonariensis* and *E. floribundus* have not been described in Cooke's FLORA OF THE PRESIDENCY OF BOMBAY. *Erigeron floribundus* (H.B.K.) Sch. Bip. is a new plant record for India since there is no record of this in any of the Indian Floras published so far.

Many of the genera treated by Venkatesh (1948) are common to Dharwar and Bangalore. But a few like *Artemisia, Dicoma, Epaltes, Lactuca, Wedelia, Volutarella, Siegesbeckia* have not been found in Dharwar.

The plants of the family Compositae are remarkable for their ability to adapt themselves to varying environmental conditions and thus show a wide range of tolerance. Even so, the occurrence of such a large number of species of Compositae (44 species of 36 genera) distributed in a comparatively small area is worth consideration. A good many of these plants show a wide range of distribution extending from the moist forests of the Western Ghats to the dry tracts of the Deccan Plateau. But a few have a restricted distribution. *Glossocardia, Glossogyne, Launaea, Vicoa,* and *Senecio* are commonly found in the dry tracts of the western Peninsula. *Elephantopus, Cyathocline, Laggera, Blepharispermum, Sclerocarpus, Synedrella,* and *Gynura* are restricted to the deciduous and moist forest areas of the Western Ghats. Such an admixture of plants of different habitats is only possible if the environmental factors are those that are intermediate between the dry tracts and deciduous forests. It has already been pointed out that Dharwar lies on the transitional zone between the plain on the east and the deciduous forests of the west-south-west. It is natural, therefore, that the species from the dry and moist localities should occur here together in the process of their migration. This incidentally explains the occurrence of a large number of Composites in this locality.

Santapau (1946) noted that he left out the genus *Blepharispermum* as he had no information about the colour of the flowers of this plant. This plant has pure white flowers.

SUMMARY

A detailed survey of the plants belonging to the family Compositae was carried out during the period 1957 to 1959. As many as 44 species of 36 genera have been listed from this locality. Out of this, 18 species are found to be new records for this area and one, *Erigeron floribundus* (H.B.K.) Sch.-Bip., is a new record for India.

An artificial key for the genera represented from Dharwar is given and this key is based on more reliable characters of the capitulum.

Brief ecological notes regarding the habitats of some species are given and habitat-indicator value of some of the more important species is pointed out.

Finally, the occurrence of this large number of Composites and the admixture of species growing in different habitats are explained as due to the situation of Dharwar in the intermediate zone between dry plain on the east and the Western Ghats on the west.

ACKNOWLEDGEMENTS

The writers are grateful to Prof. L. K. Gunjikar, Head of the Botany Department, Karnatak College, Dharwar, for encouragement and help during the course of this study. We are also thankful to Rev. Fr. H. Santapau, S.J., Ph.D., St. Xavier's College, Bombay, for going through the manuscript and making suggestions. Our thanks are also due to the authorities of the Botanical Survey of India, Western Circle, Poona, for allowing us the use of their herbaria, and to the Kew authorities for determining the identity of *Erigeron floribundus* and *E. bonariensis*.

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Observations on the Breeding of Major Carps in Madhya Pradesh[1]

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(*With two plates and four text figures*)

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1. INTRODUCTION

The efforts now being progressively made in India by the State and Central Governments to increase inland fish production by culturing major carps such as *Labeo rohita*, *Catla catla*, and *Cirrhina mrigala* in impounded waters have resulted in an increased demand for the fry of these fishes for stocking purposes. The fry is largely collected in East Bengal, either from rivers or from tanks of the bund type. Since major carps do not normally breed in captivity, considerable difficulty is being experienced in augmenting the supply to meet this growing demand. Hora (1945), in concluding the symposium on 'Factors influencing the spawning of Indian Carps', stated that the flood condition of a river or a tank is the primary factor responsible for the spawning of major carps, and that a high pH value and oxygen content of water are a necessary corollary to floods, but have no independent value in inducing spawning. Saha *et al* (1957), while investigating the spawning conditions of two wet type[2] and two dry-type bunds in Midnapore, concluded that the flood water helped to lower the pH to favourable limits. Hamid Khan (1945) pointed out the role of pituitary hormones in breeding behaviour, but did not succeed by its use in inducing major carps to spawn.

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[1] Communicated by Dr. C. V. Kulkarni, Director of Fisheries, Maharashtra.

[2] Holding water throughout the year, as opposed to dry-type, which are seasonal and remain dry for a portion of the year.

Chaudhuri & Alikunhi (1957), however, achieved considerable success in breeding the fish artificially by pituitary injections prepared from major carps themselves. This achievement has great potentiality in the future for raising fry-production, but efforts to collect fry from natural sources of water continue in each State so as to meet the local requirements.

In the former Madhya Bharat Zone of Madhya Pradesh, attempts have been made since 1949 to procure as much fry as possible by discovering new spawning grounds. During the year 1958, as many as 25 lakhs of fry and fingerlings were collected but even this quantity was insufficient for the 1.25 lakh acres of water which was to be stocked. If stocking is done at the rate of 1500 fry per acre, the annual requirement would be about 187.15 million of fry and fingerlings.

2. FISH SEED RESOURCES AND BREEDING GROUNDS

Extensive survey has been undertaken in Madhya Pradesh to discover breeding grounds. A large number were located which are classified and described in the following four categories :

(*a*) River as a Home and Spawning in Inundated Fields

Breeding grounds have been located in inundated fields at Baghthera, Sonarpura, Khared, Sankalkheda, and Imalia-Jamalbagdi villages :

(i) Baghthera. (B, Sketch-map No. 1). Brooders of *Labeo calbasu*, *Labeo gonius*, and *Cirrhina mrigala*, coming from the River Vaisli along a nullah about 8 miles long, 6 ft. deep, and 10 ft. wide, have been observed to spawn in about five acres of inundated agricultural fields. The chemical conditions of the water at this spawning area are given in Table I.

TABLE I

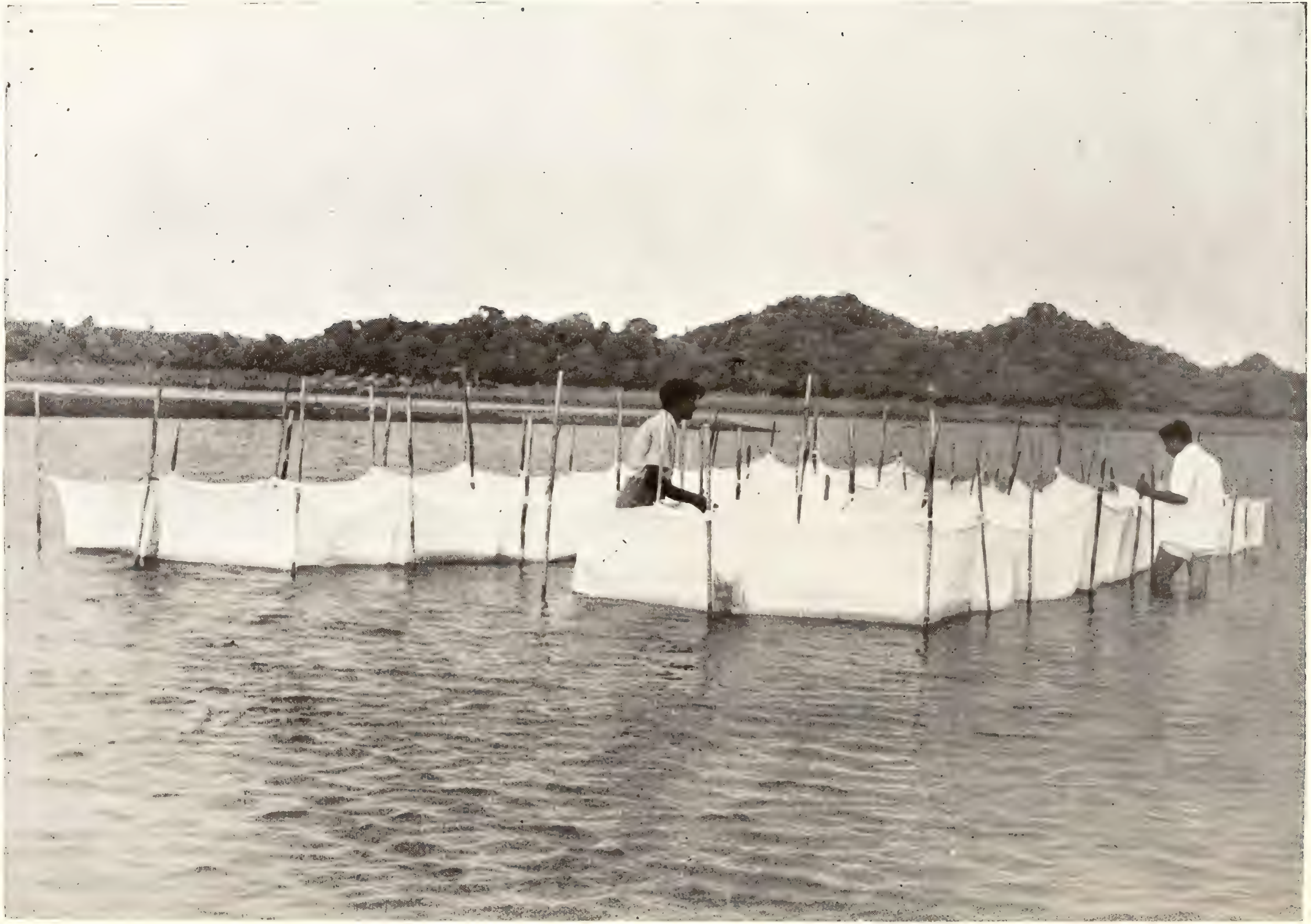
	Date	pH	Temp.	O_2	CO_2
Baghthera	8-7-58	7.6	30.00	6	2.1
Banmore	8-7-58	7.8	32.30	—	—
	9-7-58	8.2	33.30	—	—
	19-7-58	7.8	29.00	6.8	5.4
Jharoni	26-7-58	7.2	26.50	4.2	1.4
Nagda	11-7-58	7.6	30.00	—	—
Sonar-Talliya	23-7-58	8.1	26.00	—	—

(ii) Sonarpura (S, Sketch-map No. 1). Brooders of *Labeo rohita* and *Cirrhina mrigala* have been observed to migrate from the Kunwari River of the Chambal system, through a nullah about 6 miles long, 4 ft. deep, and 4 ft. wide, to spawn in about 10 acres of inundated water around this village.

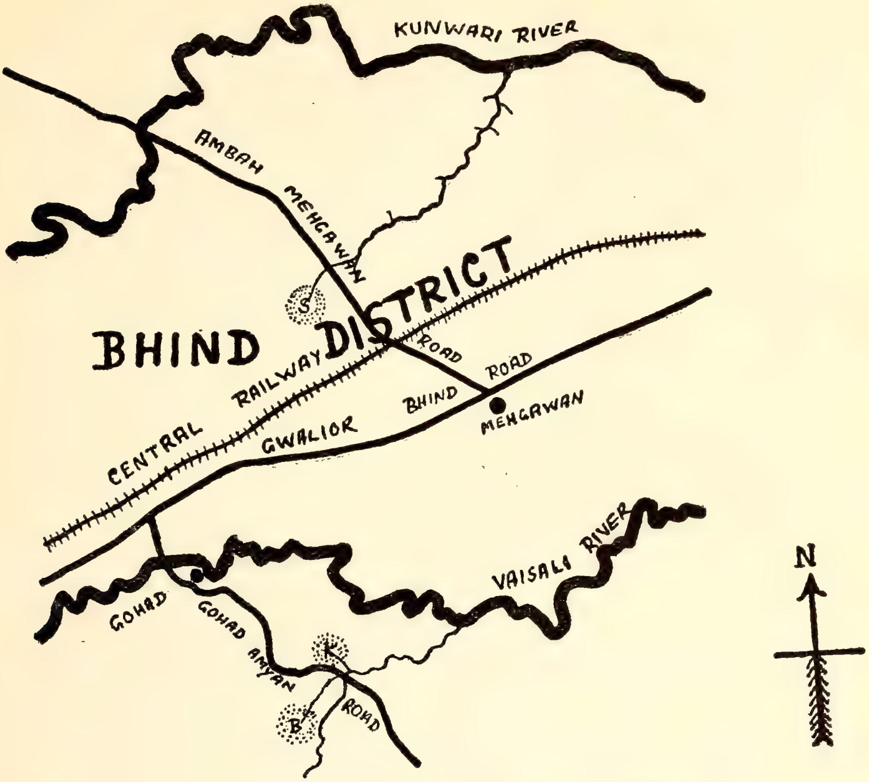
Fish-seed collection work in progress in Madya Pradesh

General view of inundated open field breeding ground

PLATE II



A Battery of Hatching Happas in Nagda wet-bund tank


KUNWARI RIVER
AMBAH
MEHGAWAN
S
BHIND DISTRICT
ROAD
CENTRAL RAILWAY
GWALIOR
BHIND
ROAD
MEHGAWAN
VAISALI RIVER
GOHAD
GOHAD
AMYAN
ROAD
K
B
N

Text Fig. 1. Bagthera, Khared, and Sonarpura Breeding Grounds
B. Baghthera breeding ground; K. Khared breeding ground; S. Sonarpura breeding ground

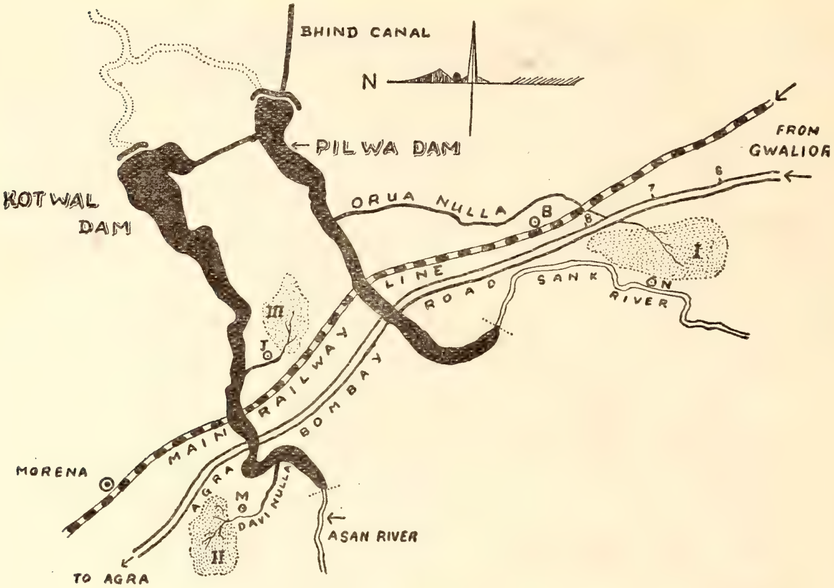
(iii) Khared (K, Sketch-map No. 1). From the Vaisli, a rivulet of the Chambal system, through a nullah about 6½ miles long, 10 ft. wide, and 6 ft. deep, brooders of Rohu, Catla, and Mrigal have been observed to spawn in an area of about 200 acres around this village. In the year 1958, as many as 8 lakhs of fry were collected from this area.

(iv) Sankalkheda. Spawning of *Labeo gonius* has been observed in the catchment area around a 12-mile-long nullah, 12 ft. wide and 8 ft. deep, which joins the River Betwa.

(v) Imalia-Jamalbagdi. *Labeo calbasu*, *Labeo gonius*, and *Cirrhina mrigala* have been observed to spawn in the inundated fields located in this village around a nullah 10 miles long, 6 ft. wide, and 4 ft. deep, which is connected with the River Betwa.

(*b*) Reservoir as a Home and Spawning in Inundated Fields

(i) Banmore spawning centre (Sketch-map No. 2). This is an important carp breeding centre and is located in the agricultural land (I) near Niraoli village (B) in Gwalior District. The nullah, known as Orua



Text Fig. 2. Banmore, Maharajpura, and Jharoni Breeding Grounds
N. Niraoli village ; B. Banmore village ; J. Jharoni village ; M. Maharajpura village ; I. Banmore breeding ground ; II. Maharajpura breeding ground; III. Jharoni breeding ground.

nullah, connects the field with Pilwa reservoir which is bunded on the River Sank, a tributary of Chambal River. The monsoon in this part breaks by the end of June every year. The early showers are absorbed by dry soil. Subsequent rainfall of 3 to 4 inches covers the field with a maximum depth of about 2 inches of water. The Minnows and Catfish first negotiate the shallow current and migrate from the reservoir to the open fields. They spread out to the extreme boundaries and their breeding is restricted to this fringe with a depth of 6 inches to 1 ft. of water. As the monsoon advances, the water level in the nullah increases and *Labeo rohita*, *Labeo gonius*, and *Cirrhina mrigala* reach the breeding ground and occupy the area with a depth of water of 1½ ft. to 3 ft. or more. *Catla* being deep-bodied, reaches the breeding ground when the rainfall raises the depth of water in the nullah to about 4 ft. or more. Their breeding is confined to the area immediately in the vicinity of the nullah with a depth of 4 ft. and above. The nature of the water and the soil condition are given in Tables I and II respectively.

Fishes, having distributed themselves to the different regions as stated above, embark on sexual play and courtship. The males chase the females of their own kind and dart about in the water. This includes physical contacts of the male with the female and rubbing her body and knocking against and nudging her. At the climax of this activity the pairs are seen to be locked up in an embrace, their bodies are twisted

TABLE II

		Banmore Fields	Banmore Nullah	Nagda	Bilaoli	Butt
Clay	ppm. ..	24.80	20.10	9.10	40.15	57.08
Silt	,, ..	22.70	13.50	1.63	23.05	22.42
Sand	,, ..	75.50	67.10	87.70	32.17	14.06
Total salts	,, ..	00.179	00.063	00.151	00.423	00.219
Soil pH	,, ..	9.60	8.80	7.38	7.46	6.219

NOTE : The dominant soil constituents are underlined

round each other with the fins erect and the caudal fin quivering. It is in this posture that mating occurs with vigorous splashing of the water. The eggs are then laid and fertilised. The spent fishes flounder about and start their homeward journey along the receding water. Many are left behind, stranded amidst shallow pools and puddles, and ultimately get killed.

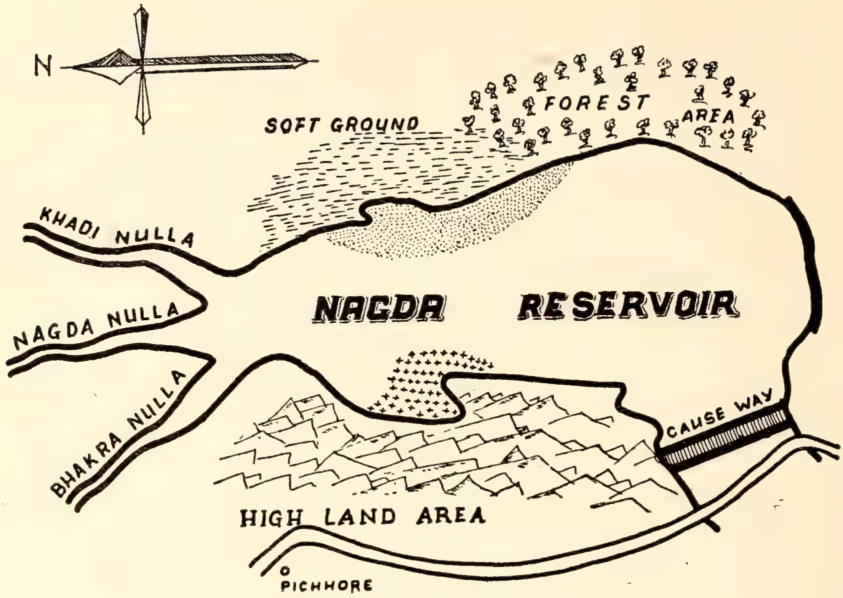
(ii) Maharajpura breeding ground (Sketch-map No. 2). This breeding site (II) was located in the fields of Maharajpura village (M). About 50 acres of the field form the catchment area around the nullah which flows into Kotwal Reservoir on the Asan Nadi, a tributary of the Chambal. The fields get inundated during the monsoon. Observations on the migration and spawning of the fishes are similar to those given under heading (i) immediately preceding.

(iii) Jharoni spawning centre (Sketch-map No. 2). The arable fields (III) of Jharoni village (J), measuring about 40,000 sq. yd., are connected by a nullah with Kotwal Reservoir. Since the discovery of this spawning ground in 1954, it has been a regular source of carp fry. In 1958, approximately 12 lakhs of fry were collected from this centre. The nature of the water at spawning time is given in Table I.

(*c*) Breeding in Reservoirs

(i) Nagda Reservoir (Sketch-map No. 3). This reservoir, measuring about 700 acres, is constructed on Budni Rivulet of Betwa River. It is essentially of the Midnapore wet-bund type. The eastern boundary is formed of hillocks and the western and southern sides are bunded. The waste-weir is located in the southern embankment. Three nullahs, Khadi, Nagda, and Bhakra, feed the reservoir. Carp spawning occurs in 50 acres of the marginal stretch within the F.T.L. (Full Tank Level) mark. The nature of the soil in this reservoir is given in Table II.

With the onset of the rains, the fresh rainwater mixes with the old standing water and spawning activities begin. The major carps spawn



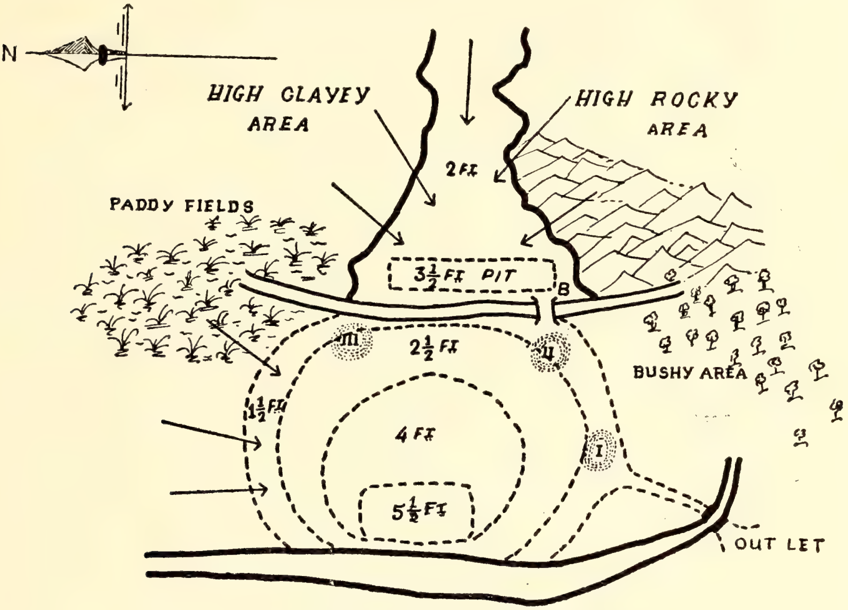
Text Fig. 3. NAGDA RESERVOIR

in one to four feet deep water. There is no current of water in the area of spawning, although there is a lot of wave-action. In 1958, as many as five lakhs of fry were collected. The nature of the water at the time of spawning is given in Table I.

(ii) Dinara and Mohari Reservoirs. Major carps were also found to breed in about 15 acres of marginal water in Dinara reservoir and in Mohari Reservoir, both constructed on tributaries of the rivers Sindh and Betwa respectively.

(iii) Bilaoli Reservoir. It is an old water-supply reservoir, 600 acres in area, situated about six miles from Indore. Its catchment area is four square miles. In 1954, the reservoir was completely dried up and stocked with the fish seed collected from Narmada River and the tributaries of the Chambal. In 1957, fry of major carps were observed in small puddles of water formed by the fall in the water level in the reservoir. During the 1958 monsoon, continuous watch was kept to observe breeding. On the 4th July, after it had rained for two days, brood fishes were noticed in the vicinity of the bund. Larger size brooders of Catla, Rohu, and Mrigal exhibited sexual play. The breeding took place along 400 yards of the stony embankment during bright sun in the forenoon. There was no flow of water as the supply of water from the tank was stopped during the monsoon.

(iv) Butt Tank. This tank is located in Chattarpur District. A nullah with an extensive catchment area has been bunded on its eastern and northern sides by raising a Chandela-type bund[1]. The total area of the reservoir is about 20 acres. Breeding of carps in this reservoir has been observed since 1957. During 1958, as many as eight lakhs fry were collected. It was interesting to note that the major carps remained in the cool shade of *Trapa* and, after rain, they left the shelter and moved out for breeding. Soil analysis of this tank is given in Table II.



Text Fig. 4. Sonar Talliya Dry-bund Tank

(*d*) Dry-Bund Breeding

Centre Sonar-Talliya (Sketch-map No. 4). As a result of the experience gained from the successful breeding of major carps in wet-bunds, an experiment in dry-bund breeding was conducted during 1958 at Sonar-Talliya, a shallow depression of 1.50 acres with an extensive catchment area. The topography of the area is hilly with arable lands towards the north. The southern side is rocky. An earthen bund was raised on the eastern side and was provided with a sluice-gate near its southern extremity. A supplementary bund was constructed on the western side. The northern and southern slopes were left open to allow the inflow of water. A more or less rectangular pit of 100 ft. × 50 ft. × 2 ft. was dug near the eastern bund for stocking the brooders. The average depth of the tank was 3^1 ft. Thus the total depth of the pit was 5½ ft. Brooders from a neighbouring tank were released into the tank and, as showers continued, more water flowed into the tank and water also started accumulating behind the western bund. The first group of brooders comprising 22 Rohu (size 15-18 in.) and six Calbasu (size 12-16 in.) was introduced on the 28th June. It rained heavily in the afternoon of the 10th July and the fish started their sexual play and at this stage a breach was made in the western bund allowing the accumulated water to flow in. They started to spawn by the evening (in the area marked I). Subsequently four Rohu (size 15-18 in.) were introduced on the 18th July and their spawning occurred in the night of the 23rd July with no fresh inflow of water (in the area marked II). After this, two Calbasu (size 13-14 in.) and six Rohu (size 16-17 in.) were introduced on the 2nd August and spawning took place during the night of the 14th August (in the area marked III). There was a slight rainfall on each day of breeding. The eggs were allowed to hatch in the tank itself and later on nearly four lakhs fry and fingerlings were collected. This dry-bund tank differs from the Midnapore type of dry bund in permitting no outflow of water at the time of breeding.

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[1] The bunds of reservoirs constructed during the regime of a former ruling dynasty, the Chandelas, were paved with stones fixed with mortar and were reinforced with earth. Bunds of this kind are referred to as Chandela-type bunds.

Table I gives the chemical conditions of the water at different breeding centres. The water was alkaline (pH 7.2-8.2), with 4.2-6.8 ppm. of oxygen, and temperature between 26-33° C. The composition of that soil as given in Table II shows that breeding can take place over clayey as well as sandy bottoms.

3. Discussions

As the result of observations made at different spawning grounds, the following conditions pertaining to carp-spawning become apparent. They breed during the south-west monsoon from the end of June every year. Breeding takes place in various depths of water, from 6 inches to 6 feet depending on the size of the brooders. Spawning occurs over hard soil, sandy soil, and even over stony embankments. Breeding occurs in open fields, wet-bund tanks, and dry-bund tanks. Each time either a light shower, or heavy or continuous rains occurred prior to breeding. The oxygen content of the water at the spawning time is between 4.2 and 6.8 ppm., pH between 7.2 and 8.2, i.e. always alkaline, and the temperature ranges between 26° and 33° Centigrade. The fishes spawn in standing waters with wave action, and with regular flow as in the open fields.

Celestial bodies like the moon have no effect, as is evident from the Appendix. Carps have spawned twice on moonless days and so far no spawning at full-moon has been observed. There seems to be no correlation between spawning and the phases of the moon.

The effects of the endocrine glands particularly that of the pituitary and thyroid glands has been conclusively pointed out by Brown (1957) who states : ' The pituitary gland is the first link between the receptor organs and the endocrine system. Environmental effects on other endocrine glands are probably mediated through the pituitary. Temperature might act directly on the gonads and the thyroid or the salinity of the environment might modify the ionic and osmotic content of the blood and thus stimulate the thyroid. However, the pituitary produces the tropic hormones and changes in the thyroid and gonads do not normally occur in the absence of pituitary. It seems safer to conclude that the external environment mediates its effect on the endocrine system through the pituitary.'

4. Conclusion

(i) Breeding takes place only after rains in various depths of water and varying currents of water-flow. It may even occur in standing water without any flow.

(ii) Soil may be hard and stony or soft and sandy.

(iii) Breeding takes place in bund type of tanks, rivers, or in open fields where rain water gets accumulated.

(iv) The pH of water may range between 7.2 to 8.2 during breeding and the temperature varies between 26° and 33° Centigrade.

(v) There does not appear to be any lunar periodicity effect in spawning as seen from the Appendix where the days of breeding and phases of the moon are indicated.

5. Acknowledgements

We are obliged to Dr. B. S. Bhimachar, Chief Research Officer, Inland Fisheries, Calcutta, and Shri G. N. Mitra, Director of Fisheries, Orissa, and Dr. H. G. Kewalramani, Bombay, for their valuable suggestions and encouragement. The co-operation of the staff of this department is thankfully acknowledged, and also the work of Shri Arjun Singh on dry-bund breeding.

APPENDIX

DATES OF BREEDING AND CORRESPONDING PHASES OF THE MOON

S. No.	Breeding Centre	Date of Breeding	Phase of Moon
1	2	3	4
1	Banmore	22-6-1952	Amavasya[1]
2	do.	23-6-1952	New moon
3	do.	11-7-1953	Amavasya
4	do.	12-7-1953	New moon
5	Nagda	10-7-1954	10th day after new moon
6	Jharoni	5-8-1954	6th day after new moon
7	Banmore	2-7-1955	13th day after new moon
8	Jharoni	10-8-1955	7th day after full moon
9	Sonarpura	30-8-1955	11th day after full moon
10	Baghthera	30-8-1955	11th day after full moon
11	Sonarpura	4-7-1956	11th day after full moon
12	Sankalkheda	4-7-1956	11th day after full moon
13	Imalia-Jamal-bagdi	10-7-1956	2nd day after new moon
14	Banmore	20-7-1956	13th day after new moon
15	Banmore	21-7-1956	14th day after new moon
16	Jharoni	21-7-1956	14th day after new moon
17	Jharoni	27-7-1956	4th day after full moon
18	Maharajpura	27-7-1956	4th day after full moon
19	Nagda	27-7-1956	4th day after full moon
20	Dinara	27-7-1956	4th day after full moon
21	Khared	8-8-1956	2nd day after new moon
22	Khared	9-8-1956	3rd day after new moon
23	Mohari	10-8-1956	4th day after new moon
24	Banmore	22-7-1957	6th day after full moon
25	Jharoni	22-7-1957	6th day after full moon
26	Maharajpura	22-7-1957	6th day after full moon
27	Khared	8-8-1957	7th day after full moon
28	Baghthera	23-8-1957	2nd day after new moon
29	Bilaoli	4-7-1958	3rd day after full moon
30	Banmore	8-7-1958	7th day after full moon
31	Jharoni	8-7-1958	7th day after full moon
32	Sonarpura	8-7-1958	7th day after full moon
33	Baghthera	8-7-1958	7th day after full moon
34	Banmore	9-7-1958	8th day after full moon
35	Nagda	11-7-1958	10th day after full moon
36	Sonar-Talliya	11-7-1958	10th day after full moon
37	Butt	22-7-1958	7th day after new moon
38	Banmore	23-7-1958	8th day after new moon
39	Sonar-Talliya	23-7-1958	8th day after new moon
40	Khared	25-7-1958	10th day after new moon
41	Mohari	25-7-1958	10th day after new moon
42	Jharoni	26-7-1958	11th day after new moon
43	Maharajpura	26-7-1958	11th day after new moon
44	Sonar-Talliya	9-8-1958	11th day after full moon

[1] The last day of the lunar month, i.e. the day previous to new moon.

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Some Observations on the Biology of the Conchostracan Branchiopod [Crustacea], *Leptestheriella gigas* Karande & Inamdar, 1960

BY

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(*With a text-figure*)

INTRODUCTION

The present communication deals with the biology of the Conchostracan Branchiopod, *Leptestheriella gigas* Karande & Inamdar, 1960, which was noted living in association with *Triops orientalis* (Tiwari) during our study of the biology of the latter (*J. Bombay nat. Hist. Soc.* **56** : 215-225) and was later described as a new species (Karande & Inamdar, 1960).

MATERIAL AND METHODS

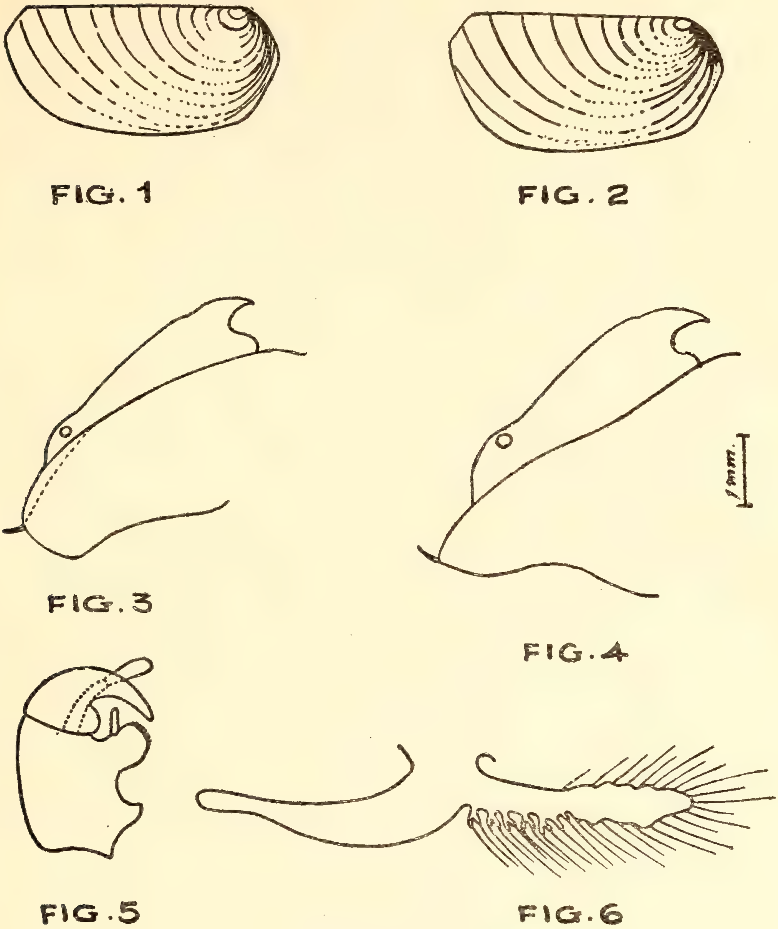
Specimens of *Leptestheriella gigas* were collected from the Tableland, Panchgani, in Maharashtra State. *L. gigas* are found here in temporary water pools from the middle of June to the end of November. As many as twelve trips were made to this place in 1957 during the monsoon when a large number of these forms were available.

OBSERVATIONS

Breeding activity

To study the breeding activity in *L. gigas* as many as 1372 specimens were collected during the different months of the year 1957. Careful examination and analysis of the collected material throws light on their egg-laying capacity, frequency of egg-laying, and the relation between body length and the number of eggs laid.

L. gigas is a prolific breeder and lays a large number of eggs, which remain attached to the exopods of the 10th and 11th limbs under the bivalve shells. The smallest size of the animal at the egg-laying stage



Leptestheriella gigas

Fig. 1. Shell of male; Fig. 2. Shell of female; Fig. 3. Profile of male head; Fig. 4. Profile of female head; Fig. 5. 'Hand' first prehensile leg of male; Fig. 6. Exopod of the third male limb.

of this species is 7.5 mm., but the number of such egg-carrying females found was very small, only three in all the females examined. The smallest size at maturity is between 8.0 and 8.9 mm., when a large number of eggs are seen attached to the oostegopods of the limbs.

The minimum number of eggs laid by female *Leptestheriella* is 140, the maximum number recorded is 1240. The egg-laying capacity increases with the size, and therefore probably with the age, of the animal. A large number of females belonging to different size-groups were examined in every month. The following table gives the average number of eggs per female in each size-group in the whole season of the year 1957.

TABLE I

Average number of eggs per female in each size-group from June to November 1957

Size-group	June	July	August	September	October	November	Average
7.0-7.9 mm.	..	..	179	139	..	..	159
8.0-8.9 mm.	..	..	494	301	213	..	336
9.0-9.9 mm.	..	284	845	1136	628	..	723
10.0-11 mm.	..	..	824	1179	419	..	807

Table I reveals that there is a definite relation between egg-laying capacity and the length of the animal. This observation is supported by the findings made in the last two seasons.

It is further observed that the breeding capacity of the individual female increases gradually as it grows, so that the number of eggs laid by a female is more than a thousand at a time (Table I). The breeding activity gradually diminishes towards the end of the life span of the female. A large number of females measuring 11.0 mm. showed hardly 100 to 150 eggs. This number was much less than the average number of 807 eggs laid by this size-group (Table I).

It is not possible to find out exactly the number of times that a single individual lays eggs. The observations based on the collected data and supported by the laboratory findings indicate that each female lays eggs at least three times during its life span which is about fifty days.

Breeding period

The observations made here show that the breeding season in this species lasts for about four months though the temporary water pools are found for about six months and the individual life span is about fifty days (Table II). A large number of females were examined and the percentage of egg-carrying females is calculated for each month of the season. The following is the record of the same from month to month.

TABLE II

Percentage of egg-carrying females collected in every month

June	July	August	September	October	November
..	33.3%	74%	36.66%	50.61%	..

In the middle of June, at the commencement of the monsoon, a large number of *Leptestheriella* develop from the resting eggs.

In July breeding activity begins and 33.3% of all the females collected show eggs under their carapaces. These females belong to 9.0 to 9.9 mm. size-group, which constitutes 22.2% of the total females collected in this month (Table III).

August may be considered as the period of maximum breeding activity when the percentage of egg-carrying females is the highest. As many as 74% of the females collected in this month show the eggs attached to their oostegopods. The majority of these females belong to 9.0 to 9.9 mm. and the rest to 10.0 to 10.9 mm. size-group. The average number of eggs laid by these females was about 800 (Table I). This number though lower than that recorded in the following month of September, is of general occurrence and hence normal for this Indian species.

In September, the percentage of egg-carrying females diminishes but there is an increase in the number of eggs carried by each individual. In the first half of this month, the majority of the females reach a peak of breeding activity and more than a thousand eggs per female are seen under the bivalve shells (Table I). But after this, in the later half of the month, most of the females die and therefore the percentage of egg-carrying females drops.

In October, the percentage of egg-carrying females increases again and 50.61% of the females carry eggs as against 74% in August and 36.66% in September. The increase in the breeding is due to the individuals belonging to the second generation which emerge by the beginning of September (Table III).

In November, the temporary water pools on the Tableland start drying up and many individuals die. At the same time a new generation arises and most of them belong to 3.0 to 7.9 mm. size-group and are therefore all juveniles.

A monthwise account of the breeding activities in *L. gigas* further suggests that 9.0 to 9.9 mm. size constitutes the most active breeding group of females and forms the principal group amongst breeding females in every month of the season.

Sex ratio in *Leptestheriella gigas*

With a view to study the sex ratio in *L. gigas* more than a thousand specimens were carefully studied. The collected material is placed in different size-groups and the sex ratio is studied groupwise for every month of the season (Table III).

TABLE III

Monthwise frequency (in percentages) of males and females of *L. gigas* in different size-groups

Size-group	June		July		August		Septem-ber		October		Novem-ber	
	Male	Femal	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
3.0 - 3.9 mm.	6.9	7.5	—	—	—	—	—	—	—	—	10	5
4.0 - 4.9 mm.	13.4	15.1	—	—	—	—	—	6.6	—	—	8	11
5.0 - 5.9 mm.	9.2	8.4	—	4.5	—	—	2.6	7.2	—	—	16	9
6.0 - 6.9 mm.	3.3	5.8	11.1	12.0	—	—	1.9	11.0	3.2	2.6	15	10
7.0 - 7.9 mm.	9.2	10.0	7.4	5.5	—	2.5	1.1	6.6	—	1.3	8	7
8.0 - 8.9 mm.	5.8	5.0	10.2	14.8	4.9	7.0	1	4.3	5.1	12.9	—	—
9.0 - 9.9 mm.	—	—	12	22.2	28.9	24.3	11.2	8.9	12.9	28.5	—	—
10.0 -11.0 mm.	—	—	—	—	19.1	13.1	20.0	16.9	16.1	17.4	—	—
No. of specimens	57	62	44	64	194	172	199	326	58	97	57	24

In June, with the onset of the monsoon, small-sized forms measuring between 3.0 to 8.9 mm. are available. In almost all the size-groups the ratio between the males and the females is found to be the same, though in a few cases there are more females than males.

In July, the forms measuring between 5.0 to 9.9 mm. are available. Amongst these the 9.0 to 9.9 mm. size-group is dominant. It may be said that *L. gigas* reaches a size of 9.9 mm. within one month's time. The number of females continues to be more than males in every size-group available in this month.

By the middle of August 32.2% of the total collected *Leptestheriella* attain the largest size, i.e. 10.0 to 11.0 mm. Others of the 9.0 to 9.9 mm. size-group constitute 53% of the total collection. The males outnumber the females particularly in the size-group 9.0 to 9.9 mm. This may be attributed to the death of a large number of females which have a shorter span of life than the males.

In September, a large number of young individuals develop which constitute a late or a second generation. In this month forms measuring between 4.0 to 11.0 mm. are found and majority of them belong to 9.0 to 11.0 mm. size-group. Once again the number of females is greater than that of males, but this is due to the emergence of the second generation, the majority of which are small-sized females. In large-sized forms measuring 9.0 to 11.0 mm., belonging to the first generation, males outnumber females (Table III). This again shows that the males have a longer span of life than the females.

In October, forms measuring 6.0 to 11.0 mm. are available and it appears that most of them, except perhaps the very few measuring 10.0 to 11.0 mm., belong to the second generation. A majority of the forms observed during this period of the season are of 9.0 to 9.9 mm. size-group (41.1%), and are about one month old. In this month females outnumber males and, unlike previous monthly findings, this dominance is seen in every size-group, except 6.0 to 6.9 mm. which is the smallest available group.

In November, as already mentioned, a large number of *Leptestheriella* die due to unsuitable conditions prevailing in the ponds. But at the same time a third generation springs up. Majority of these belong to 3.0 to 7.9 mm. size-group. Here males outnumber females in most of the size-groups.

It has been noted by many workers that the eggs of many Branchiopods need desiccation prior to hatching. Pai (1959) has noted two types of eggs in the Estherid form she studied but observes that only one type is viable. The field observations made here tend to suggest that *L. gigas* lay two types of eggs. The eggs which hatch out in the month of June are summer eggs and therefore need desiccation. It appears that some eggs, however, need no desiccation and hatch out the very same year they are deposited by the females. This view is supported by the fact that egg-laying is at its maximum in August and October and the hatching in September and November. The eggs hatching in September and November, therefore, probably belong to the second category.

HABITS

L. gigas are found in shallow ponds along with other Branchiopods like *Triops orientalis*, *Streptocephalus dichotomus*, and *Daphnia*. *L. gigas* are found in plenty particularly in shallow ponds with soft and muddy bottom, though they are not uncommon in deep rocky ponds. The temporary water-pools are at the most knee-deep and, therefore, it is very easy to catch them without the help of nets. These animals lay resting eggs like *Triops* which are able to withstand desiccation for considerable periods and may be collected during the dry season.

L. gigas are not active swimmers as compared to *T. orientalis* and other Anostracan form *S. dichotomus*. Normally they swim with their backs upwards but are occasionally seen swimming upside down like *Triops*. The limbs beat continuously throughout life, metachronal waves passing forward. *L. gigas* are very rarely seen clinging to the blades of grasses though they do not feed on them. A large number of individuals are seen grubbing in the mud by means of their antennae and the anterior limbs. This form exhibits filter feeding. The animal buries itself inversely in the mud with the gape of the bivalve shell kept wide open. The anteriorly directed food-currents are formed by the metachronal movements of the limbs. They consume bacteria, protozoons, and diatoms. Examination of the contents of alimentary canals of a large number of individuals exhibit all these in addition to algae. The pinnate type diatoms and algae constitute the bulk of their food. *L. gigas* do not feed on any Crustaceans nor do they exhibit cannibalism as *Triops* do. Their only enemy appears to be *T. orientalis* which consumes them as food (Karande & Inamdar 1959).

Many individuals are seen in sexual union, and particularly so towards the end of the monsoon. The male and the female lie one behind the other in the same axis and the former catches hold of one of the bivalve shells of the latter by means of its claspers. The male bends its abdomen and rests against the ventral side of the female on 10th and 11th ovigerous legs which bear unfertilized eggs. The fertilization takes place outside the body and inside the bivalve shell. The larva is a nauplius.

APPENDIX A

Chemical analysis of the water in the temporary water pools at Tableland, Panchgani

		Parts per 100,000
1.	Total solids	19.98
2.	Volatile and organic matter	6.88
3.	Silica (SiO_2)	3.79
4.	Iron as Fe_2O_3	1.59
5.	Alumina (Al_2O_3) by difference	1.92
6.	Lime (CaO)	2.08
7.	Magnesia (MgO)	Traces
8.	Chlorides	0.70
9.	Sulphates	Nil
10.	Alkalinity as carbonates	0.79
11.	Alkali difference	2.23
12.	Hardness permanent	1.11
13.	Hardness temporary	0.58
14.	Hardness total	1.69
15.	Ammonia saline	0.049
16.	Ammonia albuminoid	0.011
17.	Nitrates	Nil
18.	Nitrites	Nil
19.	Phosphates	Traces
20.	Poisonous metals	Nil

SUMMARY

A study of a Conchostracan Branchiopod *Leptestheriella gigas* collected at the tableland, Panchgani, Satara, Maharashtra, shows the following points of interests :

L. gigas is a prolific breeder, and the minimum size at maturity varies between 8.0 to 8.9 mm.

Minimum number of eggs deposited at a time by a female *Leptestheriella* is 140, whereas the maximum number recorded is 1240.

There appears to be a relation between the length of the animal and the number of eggs laid.

The egg-laying is at the maximum in August and October and the hatching of eggs in June, September, and November.

L. gigas attains a size of 10.0 mm. in about a month reaching a maximum size of 11.0 mm. during its lifetime.

In natural populations there are more females than males. In the large-sized stages males outnumber females. This is probably due to a shorter span of life in the females than in the males.

A possibility of *L. gigas* laying viable eggs which need no desiccation is suggested.

Field observations on feeding and breeding habits supported by laboratory findings are incorporated.

An analysis of the water in the temporary water-pools at Tableland, Panchgani, is appended.

ACKNOWLEDGEMENTS

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The Birds of Nepal

PART 3

BY

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[*Continued from Vol.* **57** (3) : 546]

Order STRIGIFORMES

Family STRIGIDAE

246. **Otus spilocephalus spilocephalus** (Blyth) $\gtrless$ **huttoni** (Hume). Spotted Scops Owl.

CHITLANG VALLEY : Chitlang : 1 ♂ (April 19).

The Spotted Scops Owl does not appear to be a common bird of Nepal. The only specimen obtained by us was found in the forest at Chitlang.

Proud (1955, p. 70) found it common on the hills round the Nepal Valley, especially between *c.* 1830 and 2590 m. Rand & Fleming (1957, p. 77) occasionally heard it in western and eastern Nepal, and had a specimen from the Nepal Valley. Neither Scully (1879), nor Ripley (1950b) record it from Nepal.

Measurements : 1 ♂ : Wing 144; tail 75; bill from skull 20, bill from anterior edge of nostril 11.

While my specimen from central Nepal appears somewhat closer to the nominate eastern race, Rand & Fleming's single example from the Nepal Valley is closer to the western *huttoni.* Baker (1927, p. 429) reported intermediate birds from Nepal. It would appear, therefore, that the two races intergrade in central Nepal.

247. **Otus scops sunia** (Hodgson). Northern Indian Scops Owl.

BHABAR : Amlekhganj : 1 ♂ (March 10).

This Scops Owl is another rare bird of Nepal. We heard it only a few times in the bhabar and dun of central Nepal. Ours appears to be the only post-Hodgsonian record of this bird from Nepal.

Measurements : 1 ♂ : Wing 142 ; tail 63 ; bill from skull 20 ; bill from the anterior edge of nostril 11.

248. **Otus bakkamoena lettia** (Hodgson). Eastern Collared Scops Owl.

Dun : Hitaura, Paharé Ghat : 5 ♂♂, 4 ♀♀, 3 juv. ♀♀ (May 11—June 23).

We found the Collared Scops Owl commonly in the central dun. We were unable to locate it in the Nepal Valley, although Hodgson found it in the 'Central and northern hills', Scully (1879, p. 232) obtained a young bird there on May 30, and Proud (1955, p. 70) found it to be common there almost throughout the year. Both Ripley (1950b, p. 372) and Rand & Fleming (1957, p. 77) found it only in eastern Nepal in winter.

Of the three juvenile specimens, the youngest one (June 14) has rufous coloration of plumage, and is downy on the back and underside. A slightly older bird (May 29) is greyish rufous. A still older one (June 22) is pale greyish and is downy on the nape and upper back.

Two of my female specimens (June 11) have granular ovaries.

Colours of soft parts : Iris yellowish brown ; cere greyish olive ; upper mandible slaty with pale base and black anterior half, lower mandible pale yellow with dusky on sides (once both mandibles dark slaty with pale base) ; feet fleshy grey ; claws dark horny, paler on bases ; pads yellowish white.

Measurements :

	5 ♂♂	4 ♀♀
Wing :	158, 160, 164, 165, 168	159, 165, 172, 180
Tail :	75, 84 (2), 85 (2)	83, 85, 86, 89
Bill from skull :	24, 24.5, 25 (3)	24, 24.5 (2), 25
Bill from anterior edge of nostril :	13.5, 14 (2), 14.5, 15	13.5, 14 (2), 15

*249. **Bubo bubo bengalensis** (Franklin). Great Horned Owl.

This owl has not been reported from Nepal after Hodgson, except by Rand & Fleming (1957, p. 77) who obtained a single specimen in west-central Nepal at *c*. 915 m. in January.

*250. **Bubo nipalensis nipalensis** Hodgson. Forest Eagle-Owl.

The only post-Hodgsonian record of the Forest Eagle-Owl from Nepal is provided by Scully's (1879, pp. 231-232) observation at *c*. 2135 m. on the Sheopuri Range, Nepal Valley.

*251. **Bubo coromandus coromandus** (Latham). Dusky Horned Owl.

The only record of the Dusky Horned Owl from Nepal is based on Hodgson's collection from the ' Lower Hills and Tarai of Nepal ' (Gray & Gray, 1846, p. 51).

252. **Bubo zeylonensis leschenault** (Temminck). Indian Brown Fish Owl.

Dun : Hitaura : 2 ♂♂, 2 ♀♀, 1 juv. ♀ (May 25-June 20).

The Brown Fish Owl is not uncommon in the dun of central Nepal. However, we did not come across it in the Nepal Valley where it was reported by Ripley (1950b, p. 372) and Proud (1955, p. 70). Ripley found it in the western tarai also. Rand & Fleming (1957, p. 78) recorded it from west-central and eastern Nepal. Scully (1879) did not list this bird.

Remains of crab and fish were found in the stomachs of my specimens.

All my adult birds are worn. A female (May 25) is just beginning to moult, and a male (May 26) which has very worn wings, has freshly moulted body feathers and tail; its chin and throat are still moulting.

Compared with the adult, the juvenile bird (June 10) has the streaks on the upper parts narrower and browner, and its general coloration is no more rufescent; its abdomen and vent are downy with narrower streaks, and it has mere traces of white patch on the throat and breast. It is highly worn and is just beginning to moult.

Measurements :

	Wing	Tail	Bill from skull	Bill from anterior edge of nostril
2 ♂♂ :	413, 426	201, 208	49, 52	29 (2)
2 ♀♀ :	—, 415	— 197+	51, 52	26, 27

253. **Bubo flavipes** (Hodgson). Tawny Fish Owl.

Dun : Hitaura : 1 ♂, 1 juv. ♂, 1 juv. ♀ (May 18-June 2).

The Tawny Fish Owl is not common in Nepal. We came across it only in the forests of the Hitaura dun, central Nepal.

It has not been recorded from Nepal by either Scully (1879), or Ripley (1950b) or Rand & Fleming (1957).

The adult male specimen had remains of fish in the stomach.

Compared with adult birds, the juvenile female (May 18) has the upper plumage with distinct spots, and narrower and browner streaks; its under plumage is downy, chin white, and the streaks finer and paler; and its tarsi are covered with down up to about 24 mm. above the base of the middle toe. The juvenile male (June 2) is very similar to the juvenile female, but without spots on the upper plumage.

Measurements : 1 ♂ : Wing 452 ; tail 226 ; bill from skull 48, bill from anterior edge of nostril 27.

254. **Glaucidium brodiei brodiei** (Burton). Western Collared Pygmy Owlet.

Dun : Bhimphedi : 1 ♀ (March 13). Chitlang Valley : Chitlang : 2 ♂♂, 1 ♀ (April 20). Nepal Valley : Thankot : 1 ♂ (March 28).

The Collared Pygmy Owlet is not uncommon in the thick forests of central Nepal from the Valley down to the upper dun.

Scully (1879) did not find it in Nepal. Rand & Fleming (1957, p. 78) reported it also from west-central Nepal.

A male and the female from Chitlang had full breeding gonads on April 20.

Remains of grasshoppers, beetles, and other insects were found in the stomachs of my specimens.

Measurements :

	Wing	Tail	Bill from skull	Bill from anterior edge of nostril
3 ♂♂ :	88, 88.5, 93	56, 57, 60	14 (3)	9, 9.5, 10
2 ♀♀ :	96, 98	61, 65	15 (2)	10, 10.5

The well-known variation of the coloration in this form has been amply summarized by Kinnear (1937, pp. 490-491), Mayr (1938, p. 315) and Rand & Fleming (1957, p. 78).

255. **Glaucidium radiatum radiatum** (Tickell). Jungle Owlet.

Tarai : Simra : 1 ♂, 1 ♀ (March 4, 5). Bhabar : Amlekhganj : 1 ♂ (June 8). Dun : Hitaura : 2 ♂♂, 1 ♀, 1 juv. ♀ (June 9, July 8-11).

The Jungle Owlet is fairly common in the forests of the tarai, bhabar and the dun of central Nepal, up to about *c*. 915 m.

Scully (1879) did not find it in Nepal. Rand & Fleming (1957, p. 79) recorded it from the lowlands of west-central and eastern Nepal.

The March specimens (1 ♂, 1 ♀) are slightly worn.

The female specimen from Hitaura (July 10) is just completing wing moult, the remiges still having the sheaths on their bases.

One of the male specimens from Hitaura (July 8) still has some down on the throat and vent, but is otherwise fully adult.

The juvenile female bird (July 11) is quite small and downy on the throat and vent.

The male specimens taken in June had their testes but slightly swollen.

Measurements :

	Wing	Tail	Bill from skull	Bill from anterior edge of nostril
4 ♂♂ :	127, 129 (2), 133	67, 70 (2), 73	18 (2), 18.5, 19	11(2), 12, 12.5
2 ♀♀ :	129, 134+	68+, —	20 (2)	11.5, 12

256. **Glaucidium cuculoïdes cuculoïdes** (Vigors). Western Himalayan Barred Owlet.

Bhabar : Amlekhganj : 1 ♀ (March 9). Dun : Hitaura : 5 ♂♂, 1 juv. ♂ 5 ♀♀, 1 juv. ♀ (May 12, 26, June 7-23, July 14, 15). Chitlang Valley : Chitlang : 1 ♂ (April 23).

The Barred Owlet is a common bird of the thick forests of central Nepal from the bhabar to the Nepal Valley.

Scully (1879, p. 233) reported it from Nawakot district, central Nepal, and once in the Nepal Valley. Ripley (1950b, pp. 372-373) found it from the foothills up to *c.* 2745 m. Rand & Fleming (1957, p. 79) recorded it from the tarai and foothills of west-central Nepal.

Compared with adult birds, the juvenile specimens (1 ♂, 1 ♀, June 9, 15) are more rufous with the head and neck spotted but the breast barred, and with pointed primaries and growing primary coverts.

A male specimen from Hitaura (June 19) has the wing, wing coverts and rectrices in moult, the latter moulting all at the same time.

A female bird was laying on May 12, while a male and another female, both taken on June 7, had only slightly swollen testes and exhausted ovary. Breeding obviously was over with them.

Remains of insects were found in the stomachs of some of my specimens.

Colours of soft parts : Iris yellow ; cere greenish horny ; bill yellowish green ; feet dull horny green ; claws dark horny, pads chrome yellow.

Measurements :

	5 ♂♂	6 ♀♀
Wing :	143, 147, 150, 151, 158	145, 148, 150, 152 (2), 153.5
Tail :	75+, 82, 84, 85+, 89	77+, 80, 80+, 82+, 83+,88
Bill from skull :	19 (2), 20, 20.5, 21	19, 20 (3), 20.5, 21
Bill from anterior edge of nostril :	12, 12.5, 13 (2), 14	12, 12.5 (2), 13 (3)

Specimens from central Nepal show a slight leaning towards the eastern subspecies *austerum.*

Ripley (1948, p. 199) stated that *G. radiatum* and *G. cuculoïdes* were allopatric, the former being found at lower elevations of the Himalayas where it replaces the latter. He further said (1950b, pp. 372-373) that *G. cuculoïdes* 'may occur on the edges of the latter's [*G. radiatum*'s] territory at times.' From the facts recorded above, however, this appears to be only partially true. In central Nepal there is a zone comprising parts of the bhabar and dun (alt. *c.* 245-915 m.), where both the species not only occur side by side but breed in the same forests. Above this zone, *G. cuculoïdes* is predominant, and below this, *G. radiatum.* Curiously, both the species seem to be more common in this zone of overlap. Abundance of food and cover may perhaps be the main factors for their occurrence in greater numbers there.

The difference in the breeding seasons of the two species, as suggested by Ripley (loc. cit.), is not very evident from my data. In my two June males of *G. radiatum* breeding appeared to be over, as it was also in a male and a female of *G. cuculoïdes* taken in June, while another female of the latter was laying in May. If there is any difference in their breeding seasons at all, it must be very slight. As the evidence stands, I believe *G. cuculoïdes* remains as a marginal ecological competitor with *G. radiatum.*

257. **Ninox scutulata lugubris** (Tickell). Indian Brown Hawk-Owl.

Tarai : Simra : 2 ♀♀ (March 4, June 10). Dun : Hitaura : 4 ♂♂ (May 19, 30, June 2, July 7).

The Brown Hawk-Owl was not infrequently seen by us hawking insects at dusk near the edges of forests of the tarai and dun of central Nepal.

Proud (1949, p. 716) noted a pair all the year round in the Nepal Valley. Ripley (1950b, p. 373) found it only in the western tarai. Rand & Fleming (1957, pp. 79-80) record it from the lowlands and foothills of west-central and central Nepal. Scully (1879) did not mention it in his list.

Remains of insects were found in the stomachs of some of my specimens.

Measurements :

	Wing	Tail	Bill from skull	Bill from anterior edge of nostril
4 ♂♂ :	206+, 213, 221, 225	115, 125, 131, 140	22, 23, 24 (2)	12 (2), 12.5, 13.5
2 ♀♀ :	217+, 219	126, 133	21, 24	12, 13.5

258. **Athene brama indica** (Franklin). Northern Indian Spotted Owlet.

Tarai : Simra : 1 ♂ (March 5). Dun : Hitaura : 2 ♂♂, 2 ♀♀ (May 21, June 23, July 7, 12). Nepal Valley : Kathmandu : 3 ♂♂ (March 23—April 9).

The Spotted Owlet appears to be the commonest nocturnal bird of prey in Nepal. Most towns and villages of central Nepal have this owlet. Scully (1879, p. 232), however, ' never observed it in the valley of Nepal'. Polunin (1955, p. 895) recorded it from *c.* 2745 m. in the Langtang Valley, central Nepal, in summer.

Specimens taken during late March and early April had only slightly swollen gonads.

Colours of soft parts : Iris lemon yellow ; cere dirty green ; bill dingy greenish yellow ; feet dirty yellowish green ; claws dark horny ; pads yellowish white.

Measurements :

	6 ♂♂	2 ♀♀
Wing :	160, 162, 163, 168, 169 (2)	164, 171
Tail :	76, 77, 81, 82, 84 (2)	80, 83
Bill from skull :	20, 20.5, 21 (3), 22	22, 23
Bill from anterior edge of nostril :	12, 12.5, 13, 14 (2), 14.5	13, 14.5

*259. **Strix leptogrammica newarensis** (Hodgson). Himalayan Brown Wood Owl.

This Wood Owl was not found by us or by Ripley (1950b) or Rand & Fleming (1957). Scully (1879, p. 230), however, recorded it as a common resident bird in the Nepal Valley, and as a winter visitor in Nawakot district. Proud (1949, p. 716) saw one pair all summer in the Valley.

[**Strix ocellata grisescens** Koelz. Northern Mottled Wood Owl.

The Mottled Wood Owl has never been taken in Nepal, but Ripley (1950b, p. 373) probably heard it in the western tarai and the eastern foothills.]

*260. **Strix aluco nivicola** (Blyth). Eastern Tawny Wood Owl.

The post-Hodgsonian records of the Tawny Wood Owl are Ripley's (1950b, p. 373) who heard it in eastern Nepal at *c.* 2440 m. in winter, and Lowndes's (1955, p. 36) who found a single example in the pine forest at *c.* 2745 m. in Manangbhot, central Nepal, in mid-August.

*261. **Asio otus otus** (Linnaeus). Long-eared Owl.

Hodgson's specimen as listed by Gray & Gray (1846, p. 52) provides the sole record of the Long-eared Owl from Nepal. Since Nepal is far away from the known range of this species, Hodgson's example was obviously a stray one.

262. **Asio flammeus flammeus** (Pontoppidan). Short-eared Owl.

NEPAL VALLEY : Chandragiri Pass above Thankot : 1 ♂ (April 13).

The only specimen of the Short-eared Owl encountered by us in Nepal is the one mentioned above. Scully (1879) and Ripley (1950b) did not report it from Nepal. Rand & Fleming (1957, p. 80) found it in the eastern lowlands in winter.

My specimen was very fat, and its stomach contained the remains of a male Rufousbellied Niltava (*Niltava sundara*).

Measurements : 1 ♂ : Wing 317+ ; tail 143+ ; bill from skull 29, bill from anterior edge of nostril 14.

*263. **Tyto alba stertens** Hartert. Indian Barn Owl.

Scully (1879, p. 229) made the last recorded collection of the Barn Owl in Nepal. He found it as a resident bird in the Nepal Valley.

*264. **Phodilus badius saturatus** Robinson. Northern Bay Owl.

The only record of the Bay Owl from Nepal is based on Hodgson's collection (Gray & Gray, 1846, p. 53).

Order CAPRIMULGIFORMES

Family CAPRIMULGIDAE

265. **Caprimulgus indicus hazarae** Whistler & Kinnear. Himalayan Jungle Nightjar.

DUN : Bhimphedi : 1 ♂ (May 8). MARKHU VALLEY : Deorali : 1 ♂, 1 ♀ (May 2). CHITLANG VALLEY : Chitlang : 1 ♂, 1 ♀ (April 17, 23).

The Himalayan Jungle Nightjar is not uncommon in central Nepal from the upper limits of the dun northward. In the Nepal Valley, we were unable to actually observe it, but probably heard it at Thankot early in April. However, it was found there by Scully (1879, p. 236) at the foot of the hills as an uncommon bird, and by Proud (1952b, p. 669) on Nagar Jong as a common species. Stevens (1925b, p. 678) noted it breeding in the Mai Valley, eastern Nepal, in May. Ripley (1950b, p. 373) reported it from the tarai of both western and eastern Nepal in winter. Proud (1952a, p. 365) heard it in the Gandak-Kosi watershed, central Nepal, at *c.* 2440-2745 m. in spring. Rand & Fleming (1957, p. 80) recorded it from west-central Nepal in winter. Biswas (1960a) found it in the Inukhu Valley, eastern Nepal, at *c.* 2895 m. in June.

It was breeding in April. A male specimen taken April 23 had fully developed testes, and a female specimen was laying on April 17.

Measurements :

	Wing	Tail
3 ♂♂ :	200, 207, 215	133 (2), 144
2 ♀♀ :	202, 203	135, 137

266. **Caprimulgus macrurus albonotatus** Tickell. Indian Longtailed Nightjar.

BHABAR : Amlekhganj : 1 ♂ (March 7). DUN : Hitaura : 7 ♂♂, 1 juv. ♂, 4 ♀♀ (May 13—June 22, July 12).

This nightjar was found by us as a common bird of the dun of central Nepal. In the central bhabar it was noted only occasionally. We did not come across it in the Nepal Valley where it was reported by Scully (1879, p. 236) in June-July, Proud (1949, p. 715) in March-April, and Rand & Fleming (1957, p. 81) in April. It was further recorded in the Gandak-Kosi watershed, central Nepal, by Smythies (1948, p. 442—a doubtful record at *c.* 3655 m. in autumn), in the eastern tarai by Ripley (1950b, p. 373) and Rand & Fleming (loc. cit.). The latter authors found it also in western and west-central Nepal.

The juvenile male specimen (June 3) has the throat rufous, finer bars on the abdomen and vent, tips of outer tail feathers white on inner web and rufous on outer, and rufous spots on the primaries.

A male example has the central rectrices in moult on July 12.

Measurements :

	8 ♂♂	4 ♀♀
Wing :	207, 209, 214 (2), 217, 222, 223, 228	209 (2), 211, 212
Tail :	158, 160 (2), 161, 166, 168 (2), 179	158, 160, 161, 167

267. **Caprimulgus affinis monticola** Franklin. Franklin's Nightjar.

BHABAR : Amlekhganj : 3 ♂♂, 1 ♀ (March 9, 10). DUN : Hitaura : 1 ♀ (May 26).

Franklin's Nightjar was found by us in small numbers in opener parts of forests of the central bhabar and dun.

It has not been reported from Nepal by either Scully (1879) or Ripley (1950b), but Rand & Fleming (1957, p. 81) found it in the bhabar of west-central Nepal and the dun of central Nepal.

Measurements :

	Wing	Tail
3 ♂♂ :	193, 196, 202	117, 120, 124
2 ♀♀ :	197, 202	119, 120

Order TROGONIFORMES

Family TROGONIDAE

268. **Harpactes erythrocephalus hodgsonii** (Gould). Himalayan Redheaded Trogon.

Trogon (*Harpactes*) *hodgsonii* Gould, 1838, Monogr. Trogonidae, 1st ed., pl. 34. (Nepal, restricted to Hitaura, Chisapani Garhi district, by Biswas, 1959b, p. 338.)

BHABAR : Amlekhganj : 1 ♂ (March 8). DUN : Hitaura, Bhimphedi : 2 ♂♂, 1 subad. ♂, 4 ♀♀, 1 subad. ♀ (May 10—June 4).

The Redheaded Trogon is not uncommon in the dense evergreen forests of the duns of central Nepal. It was not observed by us in the Nepal Valley where Proud (1955, p. 70) found it breeding at *c.* 1830 m. Rand & Fleming (1957, p. 82) obtained it in west-central and eastern Nepal at *c.* 455 and 1220 m. Neither Scully (1879) nor Ripley (1950b) reported it from Nepal. Its quiet nature may perhaps be responsible for its apparent scarcity.

Three of my male specimens are just completing the post-juvenile moult. Two of them (March 8, May 10) still have traces of buff on the breast, and the third (May 15) has crimson feathers coming on the head. The two birds entered above as subadult (♂, ♀, May 18, 23) are passing through the post-juvenile moult.

Measurements :

	Wing	Tail	Bill
3 ♂♂ :	153+, 154, 155.5	182, 195+, —	21 (2), 21.5
4 ♀♀ :	151, 152.5, 153+, 154	180+, 183, 188+, 190	20, 20.5, 21 (2)

Regarding the use of Gould's name *hodgsonii* for this bird, see Biswas (op. cit., pp. 336-338).

Order CORACIIFORMES

Family CORACIIDAE

269. **Coracias benghalensis benghalensis** (Linnaeus). Northern Indian Roller.

Corvus benghalensis Linnaeus, 1758, Syst. Nat., 10th ed., **1** : 106. [Bengal, fixed, at Tulin, Purulia district, West Bengal, by Biswas's (1961a, pp. 217-219) neotype designation.]

DUN : Hitaura, Bhimphedi : 8 ♂♂, 1 juv. ♂, 1 ♀ (March 5, May 16—June 15).

This roller is a common bird around villages from the plains up to the duns of central Nepal.

It has been recorded from the Nepal Valley as a straggler by Scully (1879, p. 237), and a stray specimen has been obtained in Manangbhot, central Nepal, at *c.* 3655 m. in August by Lowndes (1955, p. 36). Biswas (1960a) reports it from *c.* 760-915 m. in the Arun watershed, eastern Nepal, in June.

The juvenile male bird (June 12) has only a little green on the crown and more on back, the throat and breast brown with white streaks, the abdomen and vent pale blue with dark brown shaft stripes.

Measurements :

	8 ♂♂	1 ♀
Wing :	185 (2), 189, 191.5, 193.5, 194, 195, 196	192
Tail :	117, 122, 125, 128+, 129, 131, 133, —	129
Bill from anterior edge of nostril :	26 (2), 27 (2), 28 (2), 29, 30	28.5

The central Nepal birds are somewhat intermediate between *benghalensis* and *affinis*, but most specimens are closer to the nominate race. The zone of intergradation between the two subspecies includes Nepal (east of about 85°E. lat.), north-eastern Bihar, Sikkim, northern and eastern Bengal, and western Assam (Garo Hills). In this connexion Ripley (1950b, pp. 374-375) and Rand & Fleming (1957, pp. 84-85) may also be referred.

270. **Eurystomus orientalis cyanicollis** Vieillot. Himalayan Broadbilled Roller.

Eurystomus cyanicollis Vieillot, 1819, Nouv. Dict. Hist. nat. **29** : 425. ('les Indes' = Chandernagore, Hooghly district, West Bengal, according to Stresemann, 1952, p. 519.)

Eurystomus calonyx Sharpe, 1890, *Proc. zool. Soc. Lond.* : 551. (Himalayan tarai from Kumaon to Darjiling and upper Assam.)

Eurystomus orientalis abundus Ripley, 1942, *Proc. biol. Soc. Wash.* **55** : 170. (Nanking, China.)

DUN : Hitaura : 4 ♂♂, 6 ♀♀ (May 17-29).

The Broadbilled Roller is common in the forests of the central dun, though it has not been reported from Nepal by either Scully (1879), or Ripley (1950b) or Rand & Fleming (1957).

A male specimen on May 27 had somewhat swollen testes, the right one measuring 5 × 3, and the left, 7 × 5 mm., while a female taken May 29 had very much enlarged ovary with the largest ova 3-4 mm.

Colours of soft parts : Iris dark brown ; edges of the upper eyelid and orbital skin dusky vermillion ; bill, legs and feet deep vermillion with black on the tip of bill ; claws black ; pads vermillion.

Measurements :

	Wing	Tail	Bill
4 ♂♂ :	190, 192, 195, 197.5	95, 96, 102 (2)	32 (2), 33 (2)
6 ♀♀ :	184, 187.5, 191 (2), 193, 194.5	90, 93, 95, 97, 99, 100	32.5, 33 (2), 34 (2), 35

I am unable to concur with Ripley's (1942) review (followed by Peters, 1945, pp. 245-247) of this species, at least so far as the Indian forms are concerned. According to him the breeding range of his *abundus* includes ' northern Cachar, Nepal, upper Assam,. . . . ' and that of *orientalis* (in his sense), 'southern Himalayas, ... Assam, ...', thus implying a wide overlap. This is, however, far from what we actually find. The breeding birds of Kumaon, Nepal, Garo Hills, Khasi Hills and Cachar all belong to one and the same subspecies whose name, as Stresemann (1952, p. 519) has shown, should be *Eurystomus orientalis cyanicollis* Vieillot. Sharpe's *E. calonyx* is only its synonym, and Ripley's *E. o. abundus* is merely an unnecessary renaming of *E. calonyx*[1].

The single specimen from Madras (Koelz Coll.) referred to by Ripley (op. cit., p. 172) under *orientalis*, actually came from Nilambur, Malabar, Kerala (formerly part of Madras Presidency). That specimen is an example of true *laetior* Sharpe which, as Meise (1950, p. 306) has also shown, is a perfectly valid subspecies.

I believe the Indian forms of *E. orientalis* are best treated as follows :

E. o. cyanicollis Vieillot : Himalayas from Kumaon east to Assam and northern Burma, and north to lower Amur (Siberia) and Manchuria. In winter to northern India, Burma, Malayan Peninsula, Siam, Indochina, southern China, Japan and many Indo-Malayan islands.

E. o. laetior Sharpe : Southwestern India (Kerala, and parts of Mysore and Madras).

E. o. irisi Deraniyagala : Ceylon.

E. o. gigas Stresemann : South Andamans.

Family ALCEDINIDAE

271. **Ceryle lugubris continentalis** Hartert. Himalayan Pied Kingfisher.

DUN : Hitaura : 6 ♂♂, 4 ♀♀ (May 15—June 5).

The Himalayan Pied Kingfisher is not uncommon on the rivers and streams in the dun of central Nepal. A few were also observed by us at Amlekhganj in the central bhabar.

Scully (1879) did not record it from Nepal. Proud (1949, p. 715) once found it in the Nepal Valley. Ripley (1950b, p. 374) and Rand & Fleming (1957, p. 82) recorded it from western Nepal.

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[1] In Ripley's latest work (in press), the position regarding Nepal birds is still confusing. While the breeding range of *calonyx* includes Nepal, the same country is also included, without qualifying as to breeding or wintering, in the range of *cyanicollis*. In fact, the arrangement of the subspecies remains largely similar to that proposed by him in 1942. To my knowledge, ours are the only dated and definitely breeding examples from Nepal, and I have no doubt that the breeding birds from Kumaon, Nepal and southern Assam all belong to the same subspecies.

One of my female specimens had a spent ovary on June 5.

Four male specimens taken May 15-23 are in very worn plumage, and two of them (May 17 and 21) have the central tail feathers in moult. The other two males (May 15, June 5) and all the females (May 12, 15, 22, and June 5) are in fresh plumage. This data, however, precludes the possibility of stating with any degree of certainty as to whether there is at all any sexual difference in the time of moult in this species.

Colours of soft parts : Iris almost black ; bill black with pale grey on almost the whole of basal half ; legs and feet greyish olive ; claws dark horny with whitish on tips ; pads light brownish white.

Measurements :

	Wing	Tail	Bill
6 ♂♂ :	177+, 178, 178.5, 179+, 180, 183	104, 106, 107+, —(3)	71 (2), 72, 73 (2),—
4 ♀♀ :	179, 181.5 (2), 184. 5	106 (2), 107, —	72, 73, 74, 75

* 272. **Ceryle rudis leucomelanura** Reichenbach. Indian Pied Kingfisher.

This Pied Kingfisher was not found by us in Nepal. Scully (1879, p. 238) noted it once in Nawakot district, central Nepal, in winter. Ripley (1950b, p. 374) and Rand & Fleming (1957, pp. 82-83) reported it from the lowlands of both western and eastern Nepal.

273. **Alcedo atthis bengalensis** Gmelin. Common Indian Kingfisher.

BHABAR : Amlekhganj : 1 ♂, 1 ♀ (March 7, 8). DUN : Hitaura : 2 ♂♂, 1 subad. ♂, 1 juv. ♂, 2 ♀♀, 3 juv. ♀♀, 1 juv. unsexed (May 11-15, 28, June 4, 14, 16, July 29). CHITLANG VALLEY : Chitlang : 1 ♂, 1 unsexed (April 22, 23). NEPAL VALLEY : Thankot : 1 ♀ (April 12).

This kingfisher is not so common in the Nepal and Chitlang valleys as it is in the bhabar and dun. It occurs on almost all the streams, except those in deep forests, perched on boulders or on branches of dead or living trees overhanging water.

All our May specimens are in worn plumage. The juvenile examples taken June 4, 14, and 16, correspond with Baker's (1927, p. 251) description of the first year birds.

Colours of soft parts (of a female) : Iris dark brown ; upper mandible black with pale horny on tip ; lower mandible mixed dusky and orange-brown ; legs and feet deep orange ; claws dark horny ; pads deep orange.

Measurements :

	Wing	Tail	Bill from anterior edge of nostril
4 ♂♂ :	69 (2), 70, 76	31, 32 (2), 37	31, 32.5 (2), 33
6 ♀♀ :	69.5, 71 (2), 71.5, 74 (2)	31, 32 (3), 32.5, 37	31 (3), 32.5 (2), 34
1 unsexed :	70	32	32

274. **Alcedo meninting coltarti** Baker. Indian Blue-eared Kingfisher.

DUN : Hitaura : 1 subad. ♂, 6 juv. ♂♂, 4 juv. ♀♀ (June 12-19).

The Blue-eared Kingfisher was found by us only on small hill-streams in the evergreen, dense forests about Hitaura in the central dun. It appeared to prefer dense shady spots.

I am unable to trace any earlier record of this species in Nepal.

Measurements : 1 subad. ♂ : Wing 68 ; tail 29 ; bill 36.

I fail to find any constant character by which the populations from Sikkim, Assam and northern Burma can be separated from those of the rest of India, so that *A. laubmanni* Mathews, 1925, should be treated as a synonym of *A. m. coltarti* Baker, 1919 (see also Ripley, in press).

275. **Pelargopsis capensis capensis** (Linnaeus). Brownheaded Stork-billed Kingfisher.

DUN : Hitaura : 4 ♂♂, 1 ♀ (May 20, June 2-12, July 12).

This kingfisher is found in small numbers on the larger rivers in the duns of central Nepal.

Scully (1879) and Ripley (1950b) both failed to report it from Nepal, Rand & Fleming (1957, p. 83) record it from the lowlands up to *c.* 760 m. in western and west-central Nepal.

My only female specimen (May 20) is very worn and has the central rectrices in moult.

Measurements :

	Wing	Tail	Bill
4 ♂♂ :	151, 158, 160 (2)	98, 98+, 102, 103	83 (2), 87 (2)
1 ♀ :	160	—	95

276. **Halcyon coromanda coromanda** (Linnaeus). Indian Ruddy Kingfisher.

DUN : Hitaura : 1♂, 2 ♀♀ (May 20, 29, June 10).

The Ruddy Kingfisher is indeed a rare bird in central Nepal. It was observed by us only on a few occasions in the dense forests around Hitaura in the dun. Its rarity may perhaps be due to its very shy nature and its habitat along the streams in deeply shaded dense forests.

Ours appears to be the only post-Hodgsonian record of this species from Nepal.

Measurements :

	Wing	Tail	Bill from anterior edge of nostril
1 ♂ :	113	63	45.5
2 ♀♀ :	117, 118	63, 66	48.5 (2)

277. **Halcyon smyrnensis fusca** (Boddaert). Indian Whitebreasted Kingfisher.

BHABAR : Amlekhganj : 1 ♀ (March 9). DUN : Hitaura : 1 ♂, 1 subad. ♂, 2 juv. ♂♂, 2 ♀♀, 1 juv. ♀ (May 21, 27, June 3-23). NEPAL VALLEY : Kathmandu : 1 ♂ (April 8).

The Whitebreasted Kingfisher is not as common in the Nepal Valley as it is in the duns of central Nepal. It occurs in cultivated areas, edges of forests, in and around villages and towns.

It is said to breed in March-June (Baker, 1924, p. 269 for India; Scully, 1879, p. 238, and Ripley, 1950b, p. 374 for the Nepal Valley). My only April specimen (♂, Kathmandu), however, had non-breeding gonads. A Hitaura female had an enlarged ovary on June 3, the largest ovum being 4 mm. in diameter.

The juvenile male specimen taken June 23 is very young, having bars on the sides of the throat, breast and abdomen. Another male (June 13) and a female (May 27) are a bit older, having bars only on the breast and abdomen. The subadult male (June 12) has only traces of bars on the breast, and a smaller bill.

Colours of soft parts : Iris dark brown ; edges of eyelids orange-red ; bill blood-red but dusky on base ; legs and feet orange-red ; claws black ; pads orange-red.

Measurements :

	Wing	Tail	Bill from anterior edge of nostril
2 ♂♂ :	118, 124	78, 83	48, 49
3 ♀♀ :	120, 123, —	81, 84 (2)	44[a], 47, 49

[a] The tip of bill is very blunt, perhaps due to nest digging.

Whistler & Kinnear's (1935, pp. 761-762) revision of the Indian races of *Halcyon smyrnensis*, followed by Peters (1945, p. 196), and Rand & Fleming (1957, pp. 83-84), does not seem to me to be entirely satisfactory.

From an examination (which unfortunately was not a very detailed one) of comparatively fresh material from Israel, Iran, the whole of northern and southern India, and Ceylon, coupled with the existing collections in the British Museum (Natural History) and the American Museum of Natural History, I find that the coloration of plumage in the species as a whole is highly variable, particularly the tone of blue or green on the dorsal side. The chocolate coloration is uniformly paler in Israeli and Iranian birds than in Indian. I am unable to separate the northern from the southern Indian birds on coloration alone ; in size they appear to be barely separable. Ceylonese birds are still darker, and the few specimens from southern Mysore and Salem district of Madras that I have seen, appear close to the Ceylon birds in coloration but larger in size. However, pending a critical review of the species, the following arrangement may prove satisfactory. This incidentally agrees with Baker's (1927, pp. 268-271) in the widest sense :

A.	Pale and large	Israel, Iran	*smyrnensis*
B.	Darker and larger than A	Northern India	≷
C.	As dark as B but smaller	Southern India	*fusca*
D.	Darker than B and C, and as small as C	Southern Mysore, Salem (Madras)	≷
E.	Darkest and smallest	Ceylon	*generosa*

For the time being it would perhaps be better to treat B and D as *fusca*[1].

Family MEROPIDAE

278. **Merops leschenaulti leschenaulti** Vieillot. Chestnutheaded Bee-eater.

DUN: Hitaura: 5 ♂♂, 4 juv. ♂♂, 2 juv. unsexed (May 20—June 1, 13). NEPAL VALLEY: Gokarna: 1 ♂, 1 ♀ (April 5).

In the central dun, the Chestnutheaded Bee-eater is fairly common. In the Nepal Valley, however, it was seen by us only once, a pair, which was collected.

Ripley (1950b, p. 374) reported it from the tarai, but neither Scully (1879) nor Rand & Fleming (1957) found it in Nepal.

The Nepal Valley specimens had somewhat enlarged gonads on April 5: the testes measured 6.5×5 (right) and 8.5×5 mm. (left), and the ovary 8.5×5 with a 3 mm. ovum.

Three male specimens taken May 26, 27 and June 1, are very worn, but one of them (May 27) is just finishing moult on the crown.

Of the juvenile birds, three males and the two unsexed ones (May 20, 28, 29 and June 1) are of about the same age. They all lack the black pectoral band and have some green on crown, particularly on the forecrown. The other juvenile male specimen (June 13) appears to be slightly older.

One of the juvenile birds, a male taken May 28, has moulting wings.

Colours of soft parts: Iris crimson; bill black; legs, feet and claws dark slaty; pads white.

Measurements:

	Wing	Tail	Bill
6 ♂♂:	106, 107 (2), 107.5, 108, 110	76+, 78+, 79, 80 (2), 84	35, 37 (3), 37.5, 39
1 ♀:	106.5	80	36

The species has never been known to occur in Nepal higher than the duns. Our record from the Nepal Valley at *c.* 1370 m. represents in all probability a stray occurrence there.

279. **Merops philippinus philippinus** Linnaeus. Bluetailed Bee-eater.

DUN: Hitaura: 1 ♂, 3 juv. ♂♂, 4 ♀♀, 4 juv. ♀♀, 1 unsexed (July 3-7, 15-29).

The Bluetailed Bee-eater is fairly common outside the forests in cultivated areas and about villages in the Hitaura dun central Nepal.

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[1] The arrangement of the Indian subspecies recently proposed by Ripley (in press) also appears to be unsatisfactory. While I have not particularly examined Malayan or Indo-Chinese examples, and consequently do not know if they are the same as birds from Orissa or West Bengal, I certainly would not separate the latter from those of Nepal or Uttar Pradesh.

Scully (1879), Ripley (1950b) and Rand & Fleming (1957) failed to find it in Nepal.

Almost all the specimens collected are more or less worn, and one specimen (♀, July 4) has just begun moulting.

Measurements :

	Wing	Tail	Bill
1 ♂ :	139	—	47
3 (1st yr.) ♂♂ :	128 (2), 133	146, — (2)	39, 42, 47
4 ♀♀ :	126, 127, 131 (2)	115, 124+, 128, —	43 (2), 43+, 45
4 (1st yr.) ♀♀ :	121, 122, 123, 126	— (4)	36, 37, 41, 43
1 unsexed :	131	128+	46

These specimens were included in his studies on Meropidae by Marien (1950).

280. **Merops orientalis orientalis** Latham. Common Indian Bee-eater.

TARAI : Simra : 1 unsexed (March 6).

This bee-eater is common in the plains and the cultivated parts of the tarai of central Nepal.

Rand & Fleming (1957, p. 85) reported it from the tarai of western, west-central and eastern Nepal. The only record of its occurrence in the Nepal Valley, obviously a stray one, was made by Scully (1879, p. 237) from Kathmandu.

Measurements : 1 unsexed : Wing 98 ; tail 134 ; bill 32.5.

Marien (1950) included this specimen in his studies on Meropidae.

281. **Nyctyornis athertoni athertoni** (Jardine & Selby). Bluebearded Bee-eater.

TARAI : Simra : 1 ♂, 1 ♀ (March 4). BHABAR : Amlekhganj : 1 ♂ (March 9). DUN : Hitaura : 2 ♂♂, 2 juv. ♂♂, 1 juv. ♀, 1 unsexed, 1 juv. unsexed (May 23, June 3-24). NEPAL VALLEY : Thankot : 1 ♂ (March 28).

In the Nepal Valley, the Bluebearded Bee-eater is indeed rare, though it is fairly common in the forests of the central dun, and is also found in the central bhabar and tarai.

Scully's (1879) report does not include this species. Ripley (1950b, p. 374) found it in the eastern tarai, and Rand & Fleming (1957, pp. 85-86) in the western lowlands and the Valley.

The stomach of a juvenile specimen from Hitaura had large green beetles.

The May and June birds are more or less worn, but two specimens (♂♂, June 12, 24) have just started the general post-nuptial moult beginning from the crown or forehead.

Three immature specimens (1 ♂, 1 ♀, 1 unsexed), taken together on June 3, have all completed the body moult while the wings and tails are still moulting.

Measurements :

	Wing	Tail	Bill
5 ♂♂ :	133, 134+, 137, 139, 140	124+, 127, 130, 134, 135	50, 51, 52, 53 (2)
1 ♀ :	132	128	48
1 unsexed :	132	127	46

The specimens were included in Marien's (1950) studies on Meropidae.

Family UPUPIDAE

282. **Upupa epops saturata** Lönnberg. Tibetan Hoopoe.

NEPAL VALLEY : Kathmandu : 1 ♂, 1 ♀ (March 21, April 5).

Only a few examples of the hoopoe were observed by us in the Nepal Valley from mid-March to mid-April. They were seen only in the outskirts of Kathmandu.

It has been reported to occur in the Valley as a scarce bird and only on passage by Scully (1879, p. 263) and Proud (1949, p. 715). It has also been found in the plains and tarai in winter by Scully (loc. cit.), Ripley (1950b, p. 375) and Rand & Fleming (1957, p. 85). In the northern regions of central Nepal, Smythies (1948, p. 442) found it in pairs in the Gandak-Kosi watershed at *c.* 3655-4570 m. in autumn ; Polunin (1955, p. 895) occasionally noted it in the Langtang Valley at *c.* 2440 m. and once at *c.* 4420 m. in summer ; and Lowndes (1955, p. 36) observed it at *c.* 3655 m. in Manangbhot in July-August. In the northern region of eastern Nepal, Biswas (1960a) found a stray example at *c.* 5790 m. on Pumori glacier in May.

Both my specimens had slightly swollen gonads, the ovary being granular.

Colours of soft parts : Iris dark brown ; bill dark horny or black with fleshy on the base of lower mandible and gape ; legs dull horny ; feet and claws black ; pads grey.

Measurements :

	Wing	Tail	Bill
1 ♂ :	153	106	64
1 ♀ :	146	100	54

On the taxonomy of the Indian forms of *Upupa epops*, there has been a great deal of divergent views. But the latest arrangement of the subspecies proposed by Ripley (in press) works satisfactorily, and has been followed here.

*283. **Upupa epops ceylonensis** Reichenbach. Indian Hoopoe.

The hoopoe resident in Nepal from the plains up to *c.* 1830 m. belongs to this form. We were unable to find it there, but Ripley (1950b, p. 375) and Rand & Fleming (1957, p. 85) reported it thence.

Family BUCEROTIDAE

284. **Tockus birostris pergriseus** Koelz. Common Northern Grey Hornbill.

Tockus birostris pergriseus Koelz, 1939, *Proc. biol. Soc. Wash.* **52** : 79. (Lahore, West Pakistan.)

TARAI : Simra : 3 ♂♂, 1 ♀ (March 4).

The Common Grey Hornbill is not uncommon in the central tarai in forests with tall trees in lighter parts, such as about villages, as well as in fairly dense parts. A few were also observed by us in the central dun.

Scully (1879) did not report it from Nepal. Ripley (1950b, p. 375) found it in the tarai and dun, and Rand & Fleming (1957, p. 86), occasionally in the tarai of both western and eastern Nepal.

Measurements :

		3 ♂♂	1 ♀
	Wing :	212, 219, 220	203
	Tail :	277+, 282+, 290	265+
Bill from	base of casque :	102 (2), 105	81
	anterior edge of nostril :	83, 84, 86.5	64
Casque	length :	49, 54, 59	34
	height from upper edge of nostril :	17.5, 18, 19	15.5

Whistler (1941, p. 464) followed by Peters (1945, p. 255) and Ripley (in press), among others, did not admit this form. A re-examination of fresh material from all over the range of the species reveals, however, that the northern Indian birds are constantly less brown and more grey than the southern birds, so that *pergriseus* Koelz should be accepted as a valid subspecies.

*285. **Aceros nipalensis** (Hodgson). Rufousnecked Hornbill.

This hornbill does not seem to have been reported from Nepal since Hodgson's days.

286. **Anthracoceros malabaricus malabaricus** (Gmelin). Large Indian Pied Hornbill.

DUN : Hitaura : 1 ♀ (June 4).

The large Pied Hornbill appears to be a scarce bird in central Nepal. The specimen under report was the only one seen there by us.

Neither Scully (1879) nor Ripley (1950b) recorded it in their lists. Rand & Fleming (1957, p. 86), however, found it fairly common in the western tarai.

My specimen is undergoing a complete moult, presumably postnuptial. The body feathers are in an advanced stage of moult, and there are new feathers on the head and neck. The wing and tail are still moulting. The wing moult is peculiar. The primaries start moulting from the outer side inward. After the outer six primaries are grown, moulting (of primaries) stops for a while. It then resumes from the innermost primary outward, so that the seventh primary from outside is the last to moult. The secondaries, however, moult from the outer side inward. The tail moult is centripetal.

Measurements : 1 ♀: Wing — ; tail — ; bill 119.

287. **Buceros bicornis homrai** Hodgson. Great Pied Hornbill.

Buceros homrai Hodgson, 1832, *J. Asiat. Soc. Beng.* **1** : 251. (Nepal.)
Dun : Hitaura : 1 ♂ (May 23).

The Great Pied Hornbill is indeed a rare find in Nepal, only very few specimens being seen in the central dun.

Ours appears to be the only post-Hodgsonian record of this hornbill from Nepal.

Small yellow figs were found in the stomach of my specimen.

Measurements : 1 ♂ : Wing 537 ; tail 404+ ; bill from anterior edge of nostril 280 ; casque : length 173, width 93, height 43.

Order APODIFORMES

Family Apodidae

*288. **Collocalia brevirostris brevirostris** (Horsfield). Indian Edible-nest Swiftlet.

We were unable to find the Edible-nest Swiftlet in Nepal, neither were Ripley (1950b) or Rand & Fleming (1957). Scully (1879, p. 235) noted it common on the hills round the Nepal Valley at about 1830 m. upwards in August-September. Proud (1949, p. 715), however, found it there occasionally over Nagar Jong only. In the Gandak-Kosi watershed, central Nepal, Smythies (1948, p. 442) observed it at *c.* 2440 m. in autumn, and Proud (1952a, p. 365) at *c.* 1830-2440 m. in spring.

*289. **Chaetura caudacuta nudipes** (Hodgson). Whitethroated Spine-tailed Swift.

The only post-Hodgsonian report of this swift from Nepal consists of Ripley's (1950b, p. 374) sight record at *c.* 1830 m. (above Dhankuta), eastern Nepal, in winter.

290. **Chaetura cochinchinensis rupchandi** Biswas. Rupchand's Spine-tailed Swift.

Dun : Hitaura : 5 ♂♂ (including the type), 1 ♀ (June 24, July 6).

Rupchand's Spinetailed Swift was observed by us from time to time in small flocks of about a dozen birds around Hitaura in the central dun during June-July. It was sometimes seen flying fairly low, within a few feet of the ground and parallel to it.

Measurements :

	Wing	Tail	Bill from anterior edge of nostril
5 ♂♂ :	181, 181.5, 182, 184[a], 192	46 (2), 48 (2), 49[a]	6[a], 6.25 (2), 6.5, 6.75
1 ♀ :	180	47	5.75

[a] Type specimen.

*291. **Apus melba nubifuga** Koelz. Indian Alpine Swift.

The only authentic record of the Alpine Swift from Nepal is based on specimen(s) present in the British Museum (Vaurie, 1959a, p. 21).

*292. **Apus acuticauda** Jerdon. Khasi Hills Swift.

The sole record of the occurrence of this swift in Nepal consists of the type specimen.

*293. **Apus pacificus leuconyx** (Blyth). Blyth's Whiterumped Swift.

The only record of Blyth's Whiterumped Swift from Nepal appears to be that of Biswas (1960a) who found it at *c.* 3655 m. in April-May, and at *c.* 1525 m. in June, in eastern Nepal.

294. **Apus afinis nipalensis** (Hodgson). Nepal House Swift.

Cypselus Nipalensis Hodgson, 1836, *J. Asiat. Soc. Beng.* **5** : 780. (Central region of Nepal, hereby restricted to Kathmandu, Nepal Valley.)

DUN : Hitaura : 5 ♂♂, 7 ♀♀, 1 unsexed (May 29—June 23). CHITLANG VALLEY : Chitlang : 1 ♂, 1 unsexed (April 25, 27). NEPAL VALLEY : Kathmandu, Thankot : 2 ♀♀ (April 8, May 6).

The House Swift is very common in villages and towns of central Nepal from the dun up to the Valley.

Biswas (1960a) reported it also from eastern Nepal.

One of my female specimens (May 6) while flying about with many others over the market place of Kathmandu at dusk, accidentally came in contact with an over-head electric wire and was immediately killed obviously by the impact.

The Kathmandu female bird (May 6) had a granular ovary measuring 6×4 mm. The ovary was located on the right side of the body cavity instead of the left—believed to be a unique example in Aves (Biswas, 1960b).

Measurements :

	6 ♂♂	9 ♀♀	2 unsexed
Wing :	132 (2), 133, 134, 135.5, 136	118, 129 (2), 132 (2), 133, 136, 136.5, 138.5	130, 135
Tail :	42, 45 (2), 46, 48, 49	42, 43 (2), 45 (3), 45.5, 46, 48	44, 45
Bill from anterior edge of nostril :	3, 3.5 (3), 4, —	3 (2), 3.5 (5), 3.75, —	3.25, —

295. **Hemiprocne longipennis coronata** (Tickell). Indian Crested Swift.

BHABAR : Amlekhganj : 1 ♂ (August 4). DUN : Hitaura : 1 ♂, 1 ♀ (June 1).

The Crested Swift was found by us only on a few occasions in small flocks in the central bhabar and dun.

Neither Scully (1879) nor Ripley (1950b) reported it from Nepal. Rand & Fleming (1957, p. 82) found it only in the lowlands of western Nepal.

Measurements :

	Wing	Tail	Bill from anterior edge of nostril
2 ♂♂ :	165, —	136, 140	4 (2)
1 ♀ :	161	127	4

Order PICIFORMES

Family CAPITONIDAE

296. **Magalaima virens magnifica** Baker. Great Eastern Himalayan Barbet.

DUN : Hitaura : 1 ♂, 1 ♀ (May 17, 19). MARKHU VALLEY : Deorali : 1 ♀ (April 30). NEPAL VALLEY : Thankot, Godavari : 9 ♂♂, 2 ♀♀ (April 1-6, 14, May 11-15).

The Great Himalayan Barbet is common on the hills surrounding the Nepal Valley and in the Chitlang and Markhu valleys, but not so in the central dun.

It has also been reported from eastern Nepal by Ripley (1950b, p. 375) and Biswas (1960a).

About mid-May it was found by us to feed greedily on the ripe fruits of wild black plum (Fam. Myrtaceae) in the forests around Godavari, Nepal Valley.

The gonads of the May specimens from the Nepal Valley were much enlarged, but not quite in a breeding state.

Colours of soft parts : Iris dark brown (once reddish brown) ; bill yellow on the proximal half, black on the distal half of culmen and distal quarter of the sides of upper mandible (but tip white in many examples), yellowish grey on the middle part of culmen and pale greenish yellow elsewhere ; legs and feet greenish slaty ; claws very dark horny (almost black) with greenish slaty on bases ; pads white.

Measurements :

	10 ♂♂	4 ♀♀
Wing :	140 (2), 141 (2), 141+ (2), 142, 143 (2), 148	139, 141, 142, 142+
Tail :	92, 93, 95 (3), 96, 99, 100 (2), 105	93, 94, 98,—
Bill :	41.5, 43, 45 (4), 46, 47 (2), 47.5	45, 46, 48.5, 51

Ripley (loc. cit.) rightly notes that the birds of central Nepal are somewhat intermediate between *marshallorum* and *magnifica,* and Mukherjee (1956, p. 161) shows that they are best treated under the latter. Rand & Fleming (1957, pp. 86-87), however, call their birds from west-central Nepal *magnifica*. It would thus appear that west-central Nepal also falls in the intergrading zone between the two races.

*297. **Megalaima zeylanica caniceps** (Franklin). Northern Green Barbet.

The Green Barbet was not found by us, but Ripley (1950b, p. 375) and Rand & Fleming (1957, p. 87) recorded it in the western Nepal tarai.

Ripley (1945, p. 552) followed by Peters (1948, pp. 32-33) treated *M. zeylanica* and *M. lineata* as conspecific. Rand & Fleming (loc. cit.) rightly suspected that they are not, which had already been shown by Mukherjee (1952, p. 35).

It is not clear if both the Green and Lineated Barbets were collected by Hodgson. Gray & Gray's (1846, p. 114) list mentioned only *Megalaima caniceps*, and Shelley (1891, p. 80) listed only *M. lineatus*, relegating '*Megalaima caniceps* (*nec Franklin*), *Gray*, (*Cat. Mam. &c Nepal pres. Hodgs.*, p. 114 (1846)' in its synonymy. It would thus appear that the confusion between these two species is not of recent origin, but dates back at least to 1846.

298. **Megalaima lineata hodgsoni** (Bonaparte). Hodgson's Lineated Barbet.

TARAI: Simra: 3 ♂♂, 2 ♀♀ (March 5). DUN: Hitaura: 1 ♂, 2 ♀♀ (May 27, June 19, 26).

The Lineated Barbet is common in the forests of the tarai and dun of central Nepal. We did not find it higher than the dun, but Ripley (1950b, p. 376) noted that it 'occurs as high as the Valley'.

The May-June specimens are very worn.

Measurements:

	Wing	Tail	Bill
4 ♂♂:	128, 130, 132, 134	78, 79, 81, 82	34, 35, 35.5, 36
4 ♀♀:	128+, 130, 137, 138	77+, —, 83+, 85+	34.5, 36, 37 (2)

I am not quite sure of the validity of *M. l. rana* Ripley (1950a, pp. 101-102). The size difference is not borne out by more measurements (see data in Mukherjee, 1956, pp. 162-163; Rand & Fleming, 1957, p. 88; and the table above). I have seen only one example (from Hardwar, Dehra Dun district, Uttar Pradesh) that should be *rana*, as per Rand & Fleming's observation. This specimen is slightly worn. Nevertheless, I cannot distinguish it from *hodgsoni* of central Nepal in similar plumage. Rand & Fleming have accepted *rana*.

Incidentally, *M. l. kutru* Mukherjee (1952, p. 36), which Ripley (in press) synonymizes with *hodgsoni*, is a perfectly valid subspecies on the characters given in the original description.

299. **Megalaima franklinii franklinii** (Blyth). Goldenthroated Barbet.

DUN : Hitaura : 1 ♂ (May 13). CHITLANG VALLEY : Chandragiri above Chitlang : 2 ♂♂ (April 17, 20). NEPAL VALLEY : Godavari, Thankot, Chandragiri above Thankot : 5 ♂♂, 8 ♀♀, 1 juv. ♀, 2 unsexed (March 27—April 13, May 13).

The Goldenthroated Barbet is a common bird occurring in the forests on hills surrounding the Nepal Valley, usually in the denser parts. Proud (1949, p. 714), however, found it scarce in the Valley. Rand & Fleming's (1957, p. 89) observation agrees with ours. Biswas (1960a) reported it for eastern Nepal in June. Ripley (1950b) did not record it from Nepal.

A female taken on March 31 had swollen ovary measuring 12.5 × 10 with 1.5 and 1.75 mm. ova.

The juvenile bird (♀, Thankot, April 13) has much less golden yellow on throat than the adult.

Colours of soft parts : Iris brown ; bill black with the base of the upper mandible very pale grey and basal two-thirds of lower mandible grey ; legs and feet greenish horny ; claws slaty horny ; pads white.

Measurements :

	8 ♂♂	8 ♀♀	2 unsexed
Wing :	100 (3), 101+, 102 (2), 104, 107	100 (2), 101, 102, 104, 105, 106, 107	107 (2)
Tail :	58+, 60, 62, 63 (2), 64, 67,—	62 (2), 61, 64, 65, 66 (2), 68	65, 68
Bill :	24 (2), 25, 26 (4), —	24, 26 (3), 26.5, 27 (2), 28	26, 27

300. **Megalaima asiatica asiatica** (Latham). Bluethroated Barbet.

BHABAR : Amlekhganj : 1 ♂, 1 ♀ (March 7, 9). DUN : Hitaura, Bhimphedi : 5 ♂♂, 8 ♀♀, 1 juv. ♀ (May 3-26, June 21). NEPAL VALLEY : Kathmandu, Pashupatinath, Godavari : 1 ♂, 5 ♀♀ (April 5-11, 28, May 13).

The Bluethroated Barbet is a very common bird of central Nepal from the plains to the Nepal Valley. Rand & Fleming (1957, p. 89) reported it also from western and west-central Nepal.

A female specimen taken on April 10 has the central tail feathers in moult.

The females taken in early April had much enlarged gonads measuring : 10 × 7 (with the largest ovum 4), 14 × 10 (with the largest ovum 6.25) and 9 × 6.5 (with the largest ovum 6) mm., but the one taken April 28 had a spent-up ovary. Two males collected on May 14 and June 2 also had well-developed testes.

One of my male specimens (Hitaura, May 26) is partially erythristic (=*rubescens* Baker).

Colours of soft parts : Iris brown (chocolate in a few specimens) ; edges of eyelids orange-yellow ; bill pale greenish yellow with black on culmen and anterior half of upper mandible, and deep smoky on sides of the anterior third of lower mandible ; legs and feet greenish slaty ; claws slaty horny, darker on tips ; pads greyish white.

Measurements : 7 ♂♂ : Wing 102, 104 (2), 104+, 106+, 106.5, 109 ; tail 60, 63, 64 (2), 65 (2), 65.5 ; bill 26, 27, 28 (2), 29, 29.5, —.

14 ♀♀ : Wing 100, 101, 102 (2), 102+ (2), 103, 104 (3), 105, 105+, 105.5, 109 ; tail 60+, 61, 62, 63 (2), 64 (2), 65 (3), 66, 67 (2), 67.5 ; bill 27 (5), 28 (3), 28.5 (2), 29 (2), 29.5, —.

301. **Megalaima haemacephala indica** (Latham). Indian Crimson-breasted Barbet.

TARAI : Simra : 1 ♂ (March 4).

The characteristic monotonous call of the Crimsonbreasted Barbet was heard by us only a few times in the Nepal Valley, and it did not appear to be common there. It was also found in small numbers in the tarai, bhabar and dun of central Nepal.

Hodgson's collection presented earlier to the British Museum did not contain this barbet (Gray & Gray, 1846), but his later collection included it (Gray, 1863, p. 62).

Measurements : 1 ♂ : Wing 83 ; tail 38 ; bill 18.

Family PICIDAE

302. **Micropternus brachyurus phaioceps** (Blyth). Northern Rufous Woodpecker.

Picus (*Micropternus*) *gularis* Jerdon, 1844, *Madras J. Lit. Sci.* **13** (2) : 139. (South India.) Not *Picus gularis* Wagler, 1827.

Picus (*Micropternus*) *phaioceps* Blyth, 1845, *J. Asiat. Soc. Beng.* **14** : 195. ('India proper extending eastward to Tipperah and Arracan'=Arrakan, according to Baker, 1921c, p. 99 ; restricted type locality : Calcutta, according to Whistler & Kinnear, 1934, p. 290, and Peters, 1948, p. 128.)

TARAI : Simra : 1 ♂ (March 4). BHABAR : Amlekhganj : 1 ♂ (March 7). DUN : Hitaura : 2 ♂♂, 1 juv. (♂)[1], 4 ♀♀, 1 juv. (♀) (May 15-20, 27, June 2, 13, 14).

The Rufous Woodpecker is found in small numbers in the central tarai, bhabar and dun. It must be rare in the Nepal Valley where we did not come across it, but Scully (1879, p. 250) and Proud (1949, p. 714) each noted it there only once. Rand & Fleming (1957, p. 91) found it in the western and central tarai. It has not been included in Ripley's (1950b) list.

Two of my male specimens taken May 15 and June 14 are very worn, while three of the females (May 18, 27, June 2) are in very fresh plumage, having just completed a general (probably post-juvenile) moult. The other female specimen (June 13) still has sheaths on the bases of the primaries and the tail feathers.

Both the immature specimens (May 20) have been sexed from coloration only, the one having traces of red on cheek being taken as the male.

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[1] When sexing has been done only from external characters and not from examination of gonads, it is indicated by giving the symbol in parenthesis.

Measurements :

	Wing	Tail	Bill
4 ♂♂ :	130, 130+, 131+, 133	61+, 65, 67, 68	30 (2), 30.5 (2)
4 ♀♀ :	127, 129, 131, —	65, 67, 68, —	28, 29, 30, 31

*303. **Picus squamatus squamatus** Vigors. Scalybellied Green Woodpecker.

Polunin (1955, p. 895) frequently found this woodpecker in summer at *c.* 2745 m. in the Langtang Valley, and Lowndes (1955, p. 35) recorded it in August-September at *c.* 1980 and 2895 m. in Manangbhot, both in central Nepal. There does not seem to be any other authentic record of its occurrence in Nepal.

304. **Picus myrmecophoneus myrmecophoneus** Stresemann. Little Scalybellied Green Woodpecker.

Picus striolatus Blyth, 1843, *J. Asiat. Soc. Beng.* **12** : 1000. (Himalayas and central India.) Not *Picus striolatus* Lesson, 1831, nor *Picus striolatus* MacGillivray 1840.

Picus myrmecophoneus Stresemann, 1920, *Verh. orn. Ges. Bayern* **14** : 289. (Nepal, according to Baker, 1927, p. 10.) New name for *Picus striolatus* Blyth, preoccupied.

DUN : Hitaura : 1 ♂, 1 juv. ♂, 2 ♀♀, 1 juv. ♀ (May 21, June 14, 15).

This Scalybellied Woodpecker is not a common bird of central Nepal. We came across only a few examples in the central dun.

Ripley (1950b, p. 377) found it in the western tarai, and Rand & Fleming (1957, p. 91), in the western and west-central tarai.

The immature male specimen (June 15) has the upper parts very dark with red only on the forecrown ; lower parts with very close, dark and narrow markings ; and the rump and upper tail coverts pale greenish yellow, without any orange. The immature female (June 14) has the coloration of the upper parts similar to that of the immature male, but without red on forecrown ; lower parts with the scaly markings like the adult, and with a little orange on the rump and upper tail coverts.

Measurements :

	Wing	Tail	Bill
1 ♂ :	130	90	36
2 ♀♀ :	130, 133	84, 87	34 (2)

Peters (1948, p. 135) did not recognize either *dehrae* of Baker from Dehra Dun, or *dawae* of Van Tyne & Koelz from Kangra. On an examination of the type and the topotypical series of *dawae*, I find that the Kangra birds could be readily distinguished from those of Nepal, Sikkim, central and southern India, not on the characters on which they were originally separated (Van Tyne & Koelz, 1936, p. 3), but on the coloration of the rump and upper tail coverts which are pale yellow and not orange-yellow. A few of the birds from Nepal, Sikkim, central and southern India are more yellowish than orange, but those are immature examples. I did not have an opportunity to examine any specimen from Dehra

Dun area, but it may quite be possible that *dawae* may have to be treated as a synonym of *dehrae*.

I am unable to agree to the use of J. E. & G. R. Gray's (1846, p. 117) nomen nudum *xanthopygaeus* for this bird, as proposed by Peters (1948, pp. 134-135). According to Copenhagen ruling the correct name is *myrmecophoneus* Stresemann, because a subjective synonym (such as *Brachylophus xanthopygaeus* J. E. & G. R. Gray) is not an indication in the sense of Article 25 (see Copenhagen Decisions on Zool. nom., 1957, pp. 63-64, para. 115-116).

305. **Picus canus sanguiniceps** Baker. Western Blacknaped Green Woodpecker.

306. **Picus canus gyldenstolpei** Baker. Eastern Blacknaped Green Woodpecker.

TARAI : Simra : 1 ♂, 1 ♀ (March 4, 5). BHABAR : Amlekhganj : 1 ♂, 1 ♀ (March 10). DUN : Hitaura, Kusumtar, Bhairab Thumka : 4 ♂♂, 3 imm. ♂♂, 4 ♀♀ (May 10—June 21). NEPAL VALLEY : Thankot, Godavari : 3 ♂♂, 3 ♀♀ (March 15—April 8, May 10).

The Blacknaped Green Woodpecker is common in the forests of central Nepal from the tarai up to the Valley.

Ripley (1950b, p. 377) reported it from central and eastern Nepal, and Rand & Fleming (1957, pp. 91-92), from western, central and eastern Nepal.

One of my females taken in the Nepal Valley on March 28 had somewhat swollen ovary with ova of the size of mustard seeds ; and a male taken there on May 10 had quite enlarged testes. The May-June specimens from the dun were all breeding. A male taken there on May 29 had well-developed testes, while a female taken May 28 had an oviducal egg without calcium deposition on shell, measuring 23 × 18.5 mm. It also had a 12 mm. ovarian ovum.

The May and June specimens are worn so that their ventral parts look more greyish.

Colours of soft parts : Iris brownish crimson to crimson ; bill slaty to black (once black upper mandible and slaty lower) ; legs and feet bluish slaty (once slaty) ; claws slaty horny ; pads grey-white.

Measurements :

	9 ♂♂	9 ♀♀
Wing :	145, 146, —, 148 (2), 149 (2), 150, 152	145, 147 (3), 148, 149, 150.5, 153.5, 154.5
Tail :	97+, 101 (2), 102, 105 (3), 108, —	99+, 105.5, 106, 107, 108, 109, 110, 113, 116
Bill :	40 (2), 41 (3), 41.5, 42 (2), 44	38 (3), 39, 40, 41 (2), 42, 43.5

The birds from central Nepal are almost exactly intermediate between the western *sanguiniceps* and the eastern *gyldenstolpei*, as has already been noted by Ripley (loc. cit.) for the Nepal Valley birds. The few eastern

Nepal skins I have been able to examine, are closer to *gyldenstolpei*, as has been found by Ripley. And one would expect the western Nepal birds to be closer to *sanguiniceps*. It is interesting to note, however, that Rand & Fleming (loc. cit.) designate all their birds from western to eastern Nepal as *sanguiniceps* ⋚ *gyldenstolpei*. Very recently, Vaurie (1959b, p. 17) has synonymized *gyldenstolpei* Baker with *hessei* Gyldenstolpe, 1916 (type locality : Northern Siam), using this name for ' all the populations ranging from Indochina westward through Siam and Burma to Assam and Sikkim'.

307. **Picus chlorolophus simlae** Meinertzhagen. Western Small Yellow-naped Woodpecker.

308. **Picus chlorolophus chlorolophus** Vieillot. Eastern Small Yellow-naped Woodpecker.

BHABAR : Amlekhganj : 2 ♂♂, 2 ♀♀ (March 9, 10). DUN : Bhimphedi, Hitaura : 5 ♂♂, 2 juv. ♂♂, 2♀♀, 2 juv. ♀♀ (May 10-29). NEPAL VALLEY : Thankot ; 1 ♂, 1 ♀ (April 1, 2).

The Small Yellownaped Woodpecker is not uncommon in the forests on the ranges bordering the Nepal Valley, and in the forests of the central dun and bhabar.

May and June birds are very worn, but a female (May 28) is finishing moult of the central tail feathers.

Measurements :

	Wing	Tail	Bill
8 ♂♂ :	135, 137, 138, 139,	—(2), 96, 97, 98,	—, 29.5, 30 (2), 31,
	141 (2), 142, 146	102, 103, 104	32 (2), 32.5
3 ♀♀ :	136, 137, 138	98, —, 102	29, 30 (2)

I do not agree with Ripley (1950b, p. 378) that the western Himalayan race *simlae* ' is poorly characterized '. It is quite true that the ' difference in the colour of the nuchal crest follows a continuous cline ', but so does the size. It does not seem wise, therefore, to separate the eastern and western Himalayan races solely on the basis of size difference. In view of the continuous clinal variation in colour and size, there is a fairly wide intermediate zone which includes eastern Kumaon (Nainital and Almora districts) on the west and a greater part of Nepal, the eastern limit of which may be arbitrarily taken as the Arun Valley.

The central Nepal birds reported here are almost exact intermediates between *simlae* and *chlorolophus*, both in size and in coloration. Rand & Fleming (1957, pp. 92-93) placed their western birds, including a single example from the Nepal Valley, under *simlae*, and the eastern birds from the Kamala Valley, under the nominate subspecies.

It may be mentioned in passing that the single example from the northern Eastern Ghats, reported as *chlorolophus* by Whistler & Kinnear (1934, p. 287), is likely to prove to be an example of *chlorigaster*. It is probably an immature bird where the red on the crown is confined to its borders as in adult *chlorolophus*. This is indicated by the absence of golden sheen on this specimen (mentioned by them)—a characteristic of *chlorigaster*. A little to the north of Eastern Ghats, *chlorigaster* is found in Mayurbhanj (Mukherjee, 1953, p. 163).

309. **Picus flavinucha flavinucha** Gould. Eastern Himalayan Large Yellownaped Woodpecker.

Bhabar : Amlekhganj : 1 ♂, 1 ♀ (March 10). Dun : Hitaura, Bhimphedi : 6 ♂♂, 2 juv. ♂♂, 2 ♀♀, 1 juv. ♀ (May 5-26, June 19, 21).

The large Yellownaped Woodpecker is found in small numbers in the Nepal Valley, but is commoner in the central bhabar and dun.

Scully (1879) did not find it in Nepal. Ripley (1950b, p. 377) reported it from western and eastern Nepal, and Rand & Fleming (1957, p. 92), from west-central Nepal also.

Of the immature birds, the female taken June 19 is the youngest. It has no cinnamon on chin and throat, but white with dark brown spots. An immature male collected on May 23 appears to be a little older. Its chin and cheeks are cinnamon, but the throat is still white with spots and streaks. Another male taken May 14 is still older. Its chin and anterior throat are cinnamon, throat and upper breast white with black spots, cheeks light yellow, and underside dull coloured.

Measurements :

	Wing	Tail	Bill
7 ♂♂ :	169, 170, 172, 174,	115+, 116, 118 (2),	42.5, 43 (2), 44,
	176 (2), —	120, 122, 125	44.5, 45, —
3 ♀♀ :	166, 168, 170	113, 121, 122	40 (2), 42

The abovementioned specimens have already been included in Biswas's (1952) study on the geographical variation in the species.

310. **Dinopium benghalense benghalense** (Linnaeus). Northern Goldenbacked Woodpecker.

Tarai : Simra : 1 ♀ (March 5).

The Goldenbacked Woodpecker was found by us in the tarai of central Nepal and was observed only a few times.

Scully (1879) was unable to find it in Nepal. Rand & Fleming (1957, p. 93) came across it in the western and west-central tarai.

Measurements : 1 ♀ *:* Wing 149; tail 89 ; bill 37.

311. **Dinopium shorei shorei** (Vigors). Himalayan Goldenbacked Threetoed Woodpecker.

Tarai : Simra : 1 ♀ (March 4). Bhabar : Amlekhganj : 2 ♂♂, 2 ♀♀ (March 9, 10). Dun : Hitaura, Paharé Ghat : 1 ♂, 4 subad. ♂♂, 3 ♀♀, 1 (♀), 1 juv. ♀ (May 15, 25-27, June 4, 10, 15, July 12, 26).

The Goldenbacked Threetoed Woodpecker is common in the forests of the tarai, bhabar and dun of central Nepal. In the tarai, however, we did not come across it frequently, but it did appear commoner than the Goldenbacked Woodpecker (*D. benghalense*) with which it co-exists there.

The subadult male specimens still have some streaks on forecrown, much like those of adult females. They are as large as the adult birds.

Colours of soft parts : Iris dark brown ; bill black ; legs and feet greenish horny ; claws slaty ; pads yellowish grey.

Measurements :

	7 ♂♂ (including subadult)	7 ♀♀
Wing :	154, 155, 156 (2), 157, 157+, 159	152, 154, 155+, 158, 160+, 162, 164
Tail :	96, 97, 100 (3), 104, —	99, 100, 102 (3), 102.5, 104
Bill :	39 (3), 40, 40.5, 42.5, 44	37, 37.5, 39, 39.5, 40, 40.5, —

*312. **Gecinulus grantia grantia** (Horsfield). Paleheaded Woodpecker.

The only record of the Paleheaded Woodpecker from Nepal is based on Hodgson's collection (Gray, 1863, p. 63).

*313. **Mulleripicus pulverulentus mohun** Ripley. Nepal Great Slaty Woodpecker.

The Great Slaty Woodpecker was reported from Nepal for the first time by Ripley (1950a, p. 103) who obtained a single specimen in the virgin sāl forest of the western dun. It has subsequently been found in the lowlands of west-central Nepal by Rand & Fleming (1957, pp. 93-94).

314. **Dendrocopos darjellensis darjellensis** (Blyth). Darjeeling Pied Woodpecker.

CHITLANG VALLEY : Chitlang : 1 ♂ (April 25).

We did not find the Darjeeling Pied Woodpecker at all common in central Nepal, having seen only a few on the Chandragiri Range above Thankot and Chitlang.

Scully (1879, p. 245) and Proud (1949, p. 713) noted it as common on hills surrounding the Nepal Valley. Ripley (1950b, p. 378) reported it only from eastern Nepal. Rand & Fleming (1957, p. 94) recorded it, in addition to the Nepal Valley, from the Kali Gandak Valley, west-central Nepal.

Measurements : 1 ♂ : Wing 130 ; tail — ; bill—.

315. **Dendrocopos cathpharius cathpharius** (Blyth). Himalayan Lesser Pied Woodpecker.

CHITLANG VALLEY : Chitlang : 2 ♀♀ (March 15, April 13). NEPAL VALLEY : Thankot : 2 ♂♂, 3 ♀♀ (March 23-26, April 4, 5, 13).

The Lesser Pied Woodpecker was found by us in small numbers in the forests on the base of Chandragiri Range both on Thankot and Chitlang sides.

Scully (1879) did not record it from Nepal. Stevens (1925b, p. 670) found it in eastern Nepal near Sikkim or Bengal border between *c.* 1370 and 2135 m. Proud (1949, p. 713) observed it but once in the Nepal Valley on Phulchauki Range at *c.* 1830 m. in January. While Ripley (1950b, p. 378) obtained his single specimen at Chitlang, Rand & Fleming (1957, p. 94) collected a pair at Patale (*c.* 3050 m.) in the Maulung Valley, eastern Nepal.

Measurements :

	Wing	Tail	Bill
2 ♂♂ :	97, 98	59, 62	20, 21
5 ♀♀ :	97, 99.5, 101 (2), 103	60, 61 (2), 62, 63	20, 21 (3), —

316. **Dendrocopos hyperythrus hyperythrus** (Vigors). Eastern Rufousbellied Woodpecker.

Picus hyperythrus Vigors, 1831, *Proc. zool. Soc. Lond.* (1) : 23. (Himalayas = Nepal or further eastern Himalayas, according to Hartert, 1912, p. 926 ; hereby restricted to Darjiling, West Bengal.)

Chitlang Valley : Chitlang : 3 ♂♂, 2 ♀♀ (April 16-22). Nepal Valley : Thankot, Chandragiri Pass : 1 ♂, 2 ♀♀ (March 31, April 7).

We came across the Rufousbellied Woodpecker in small numbers on the Chandragiri Range both on Thankot and Chitlang sides.

Scully (1879) did not report it from Nepal. Stevens (1925b, p. 669) found it on the Singalila Range, eastern Nepal, at *c.* 2745 m. in February. Ripley (1950b, p. 379) recorded it both from central and eastern Nepal, and Rand & Fleming (1957, p. 94), from west-central and central Nepal.

Measurements :

	Wing	Tail	Bill
4 ♂♂ :	118, 119, 121, 123	71+, 72, 75 (2)	27, 27.5, 28, 29
4 ♀♀ :	116, 120 (2), 121	70.5, 72, 72+, 73	27 (2), 27.5, 28

*317. **Dendrocopos auriceps auriceps** (Vigors). Western Brownfronted Pied Woodpecker.

Rand & Fleming (1957, pp. 94-95) place their specimens from western Nepal under this western subspecies. They note, however, that their birds are slightly smaller on average than Mussoorie birds. The eastern and western races perhaps intergrade in eastern Kumaon-western Nepal. I am unable to trace any other record of this western race from Nepal.

318. **Dendrocopos auriceps incognitus** (Scully). Eastern Brownfronted Pied Woodpecker.

Picus incognitus Scully, 1879 *Str. Feath.* **8** : 246. (Residency Grounds, Kathmandu, Nepal.)

Dendrocopus auriceps conoveri Rand & Fleming, 1956, *Fieldiana, Zool.*, **39** : 1. (15 miles west of Tansen, Kali Gandak Valley, Palpa district, Nepal.)

Dun : Bhimphedi : 2 ♀♀ (March 12, 13). Markhu Valley : Kulikhani : 1 juv. ♀ (July 2). Chitlang Valley : Chitlang : 3 ♂♂, 1 ♀ (April 16-22). Nepal Valley : Thankot : 3 ♂♂, 1 ♀ (March 30—April 11).

In central Nepal, the Brownfronted Pied Woodpecker is fairly common on the Mahabharat and Chandragiri ranges as well as on other ranges surrounding the Valley.

Polunin (1955, p. 895) reported it from the northern region of central Nepal in the Langtang Valley at *c.* 2745 m. and less in summer. Rand & Fleming (1957, p. 95) found it in west-central Nepal also. Biswas (1960a) observed it at *c.* 1830 m. in the Charnawati Valley, Ramechhāp district, eastern Nepal, and I have examined specimens from a nearby region in the same Valley (Dolakha, ex Mandelli collection, in the British Museum). The range of the eastern form as defined by Rand & Fleming (1956, p. 1), therefore, needs emendation.

Measurements :

	Wing	Tail	Bill
6 ♂♂ :	107, 109+, 110, 111(3)	62, 64 (3), 65, 67	26, 26.5, 27 (2), 28 (2)
4 ♀♀ :	106, 107 (2), 108	64, 65, 66.5, —	25 (3), 27

319. **Dendrocopos macei macei** (Vieillot). Eastern Fulvousbreasted Pied Woodpecker.

TARAI : Simra : 2 ♂♂, 1 ♀ (March 4, 5). BHABAR : Amlekhganj : 1 ♂ (March 8). DUN : Hitaura : 1 ♂, 1 ♀ (May 30, June 5). NEPAL VALLEY : Kathmandu, Thankot : 1 ♂, 4 ♀♀ (March 27—April 12, May 20, July 25).

The Fulvousbreasted Pied Woodpecker is not uncommon in central Nepal from the tarai up to *c.* 1675 m. in the Nepal Valley.

Scully (1879, p. 246) recorded it in the bhabar and Nawakot district, central Nepal. Proud (1949, p. 713) observed it as common in the Nepal Valley up to *c.* 2135 m., and later (1952a, p. 365) found it also at *c.* 2745 m. in the Gandak-Kosi watershed in spring. Ripley (1950b, p. 379) collected it up to *c.* 1615 m. Lowndes (1955, p. 35) found it in August at *c.* 2440 m. in Manangbhot, central Nepal. Rand & Fleming (1957, p. 95) reported it from western, west-central and central Nepal.

My female specimen taken April 6, has the left central rectrix freshly moulted but still in sheath, while the right one is fairly worn and without any sign of moult.

A female taken April 6 had somewhat swollen ovary (8.5×5.5. with many 1 mm. ova). A male collected on May 20 also had somewhat enlarged testes (R : 4.5×2.5, L : 6×4 mm.). Another female taken May 30 was almost breeding, while the male of June 5 had much enlarged testes (R : 9×7, L : 10.5×7 mm.).

Colours of soft parts : Iris reddish brown ; upper mandible blackish horny with pale slaty on base ; lower mandible pale slaty with blackish horny tip ; legs and feet greenish slaty ; claws dark horny ; pads white.

Measurements :

	Wing	Tail	Bill
5 ♂♂ :	110 (3), 111, 116	62, 64, 65, 65.5, 66	27.5 (2), 28 (2), 28.5
6 ♀♀ :	107, 108, 109, 110 (2), 111	64 (2), 65, 66,—(2)	25 (4), 25.5, 26

The western race *westermani* Blyth appears to me to be quite distinct (*contra* Peters, 1948, p. 194 ; Ripley in press). The Punjab birds are much larger than those of Sikkim, lower Bengal and Assam. Central Nepal birds show a slight leaning towards the western race, but are closer to the eastern. Kumaon birds are, I find, intermediate between the two races. Rand & Fleming (1957, pp. 95-96), however, place the western Nepal birds along with a Nepal Valley specimen, under *westermani*, and the eastern Nepal example under *macei*.

The type locality of *Picus Westermani* Blyth, 1870, is hereby restricted to Simla.

*320. **Dendrocopos mahrattensis pallescens** Biswas. Western Yellowfronted Pied Woodpecker.

We did not find the Yellowfronted Pied Woodpecker in Nepal, nor did Scully (1879) find it there. Ripley (1950b, p. 379) reported it from the tarai. Rand & Fleming (1957, p. 96) recorded it from the lowlands of western and west-central Nepal.

321. **Dendrocopos canicapillus mitchellii** (Malherbe). Nepal Pygmy Woodpecker.

BHABAR : Amlekhganj : 2 ♂♂, 1 ♀ (March 6, 8). DUN : Hitaura, Paharé Ghat, Bhimphedi : 2 ♂♂, 1 subad. ♂, 7 ♀♀, 1 juv. ♀ (March 13, May 15-27, June 9, 10, 23).

This Pygmy Woodpecker is fairly common in the forests of central Nepal from the tarai up to the dun. It occurs in the deeper parts of forests, as well as in the clearings inside.

Two females taken June 9 and 10, had non-breeding gonads. Ripley (1950b, p. 379) found breeding birds in February and non-breeding ones in April. In Kumaon, however, it is said to breed in April and May (Thompson, quoted by Hume, 1890, p. 306 ; Baker, 1934, p. 295).

Colours of soft parts : Iris reddish brown ; upper mandible slaty to black with paler base ; lower mandible darker slaty to black on the anterior quarter, pale slaty (once very pale, almost white) on the remaining portion ; legs and feet greenish horny ; claws slaty ; pads yellowish green.

Measurements :

	5 ♂♂	8 ♀♀
Wing :	85+, 86+ (2), 88, 89	85, 87 (2), 88, 89 (2), 90 (2)
Tail :	40+, 42+, 44, 45, 46	44 (2), 46, 47 (2), 48, —(2)
Bill :	16.5 17.5, 18 (3)	17 (3), 18 (4), 18.5

A few of the abovementioned specimens were included in Biswas's (1950b) study of the taxonomy of Pygmy Woodpeckers.

*322. **Dendrocopos nanus nanus** (Vigors). Northern Pygmy Woodpecker.

Neither Scully (1879) nor we found the Northern Pygmy Woodpecker in Nepal. However, Ripley (1950b, p. 379) reported it from western, and Rand & Fleming (1957, p. 97), from western and west-central Nepal.

323. **Blythipicus pyrrhotis pyrrhotis** (Hodgson). Redeared Bay Woodpecker.

MARKHU VALLEY : Deorali : 1 ♂, 2 juv. ♂♂, 1 ♀, 1 juv. ♀ (April 29—May 1).

We came across the Redeared Bay Woodpecker only on a few occasions in the Markhu Valley, central Nepal. It may not, however, be as rare as it seems. Its occurrence in dense forests and its preference for thick undergrowth, appear to be responsible for its apparent rarity.

Scully (1879) did not include it in his Nepal list. Stevens (1925b, p. 671) recorded it from the Mai Valley, eastern Nepal, at above 2135 m. Ripley (1950b, p. 380) found a single example at Godavari, Nepal Valley ; and Rand & Fleming (1957, p. 97) obtained a specimen at Dana, west-central Nepal.

A striking colour difference between the adult and juvenile birds, which has not been noted by Baker (1927, pp. 55-56) is that the breast in a fully adult bird has a rusty wash, while in the juvenile it is dull earthy brown.

Measurements :

	Wing	Tail	Bill
1 ♂ :	153	98	52.5
1 ♀ :	151	82	51

324. **Chrysocolaptes lucidus sultaneus** (Hodgson). Hodgson's Goldenbacked Woodpecker.

TARAI : Simra : 2 ♂♂, 2 ♀♀, 1 juv. ♀ (March 4, 5). DUN : Hitaura : 3 ♂♂, 1 ♀ (May 23-26).

Hodgson's Goldenbacked Woodpecker is not uncommon on the edges of forests of central Nepal from the tarai up to the dun.

Scully (1879) did not find it in Nepal. Ripley (1950b, p. 380) recorded it from the upper tarai and dun of western Nepal, and Rand & Fleming (1957, p. 97), from west-central Nepal.

Measurements :

	Wing	Tail	Bill
5 ♂♂ :	171(2), 174, 179, 180	84, 88, 89+, 91, 100	56, 57, 58, 60, 61.5
3 ♀♀ :	174, 178, 180	98, 99 (2)	53, 56, 58

The above measurements, coupled with those furnished by Ripley (loc. cit.) and Rand & Fleming (loc. cit.) show that the central Nepal birds are somewhat intermediate between *sultaneus* and *guttacristatus*. The type locality of *sultaneus* has, however, been restricted to Simra[1], central Nepal by Ripley (loc. cit.).

*325. **Chrysocolaptes lucidus guttacristatus** (Tickell). Tickell's Goldenbacked Woodpecker.

Ripley (1950b, p. 380) found this eastern form breeding at Chatra,

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[1] Rand & Fleming (1957, p. 98) believe that Simra and the type locality of *C. l. guttacristatus*, namely Borabhum and Dholbhum are ' unfortunately close together'. The distance between Borabhum and Simra is about 300 miles.

Arun Valley, eastern Nepal. That appears to be the only record of this woodpecker from Nepal.

326. **Picumnus innominatus innominatus** Burton. Himalayan Speckled Piculet.

Picumnus innominatus Burton, 1835 (1836), *Proc. zool. Soc. Lond.* (3) : 154. (Himalayas, restricted to Sikkim by Baker, 1927, p. 92.)

Picumnus innominatus simlaensis Ticehurst, 1933, *Bull. Brit. orn. Cl.* **54** : 20. (Murree, West Pakistan.)

DUN : Bhimphedi : 1 ♂, 3 ♀♀ (March 12, May 5, 7). MARKHU VALLEY : Deorali : 2 ♀♀ (April 28, 30). CHITLANG VALLEY : Chitlang : 2 ♂♂, 1 ♀ (April 22-24). NEPAL VALLEY : Thankot : 3 ♂♂, 2 ♀♀ (March 21, 22, April 1, 2).

The Speckled Piculet is fairly common in central Nepal from the upper edges of the dun to the Nepal Valley. Rand & Fleming (1957, p. 90) recorded it from western and west-central Nepal.

One of my female specimens (Deorali, April 30) has no white on the central rectrices.

Measurements :

	Wing	Tail	Bill
6 ♂♂ :	55.5, 57, 57+, 59 (2), 60	30 (3), 32+, 33, —	12.5, 13 (4), —
8 ♀♀ :	58, 59 (2), 59.5, 60 (3), 61	32, 33 (2), 34 (2), 34+, 35,—	12, 12.5, 13 (5), 13.5

I am unable to recognize Ticehurst's western race *simlaensis*. The differences in size and coloration are not borne out. It is, however, true that the populations from western Himalaya tend to be slightly larger than those of eastern Himalaya. But this difference is very slight indeed and is barely perceptible in large series. Rand & Fleming (1957, p. 90) also arrived at this conclusion. Similarly, I am unable to find on fresh skins, the differences between *malayorum* and *avunculorum*, as given by Hartert (1912, p. 937), and, therefore, accept only *malayorum* with *avunculorum* as its synonym.

The races of the species will, therefore, stand as follows :

1. *P. i. innominatus* Burton (syn. *P. i. simlaensis* Ticehurst) : Himalayas to Assam (except its eastern parts).
2. *P. i. malayorum* Hartert (syn. *P. i. avunculorum* Hartert) : Peninsular India, lower Bengal, eastern Assam, Burma, Siam, Indo-china, Malaya, Sumatra and Borneo.
3. *P. i. chinensis* Hargitt : China.

Recently, Vaurie (1959c, p. 14) has suggested recognition of *simlaensis* on the basis of the males of western Himalayan birds having longer wing (10 ♂♂ : 58-61, av. 59.9 against 12 Sikkim-Bhutan ♂♂ : 55-58, av. 56.7). Still more recently, Ripley (in press) has come to the same conclusion as mine regarding No. 1 and 2.

327. **Sasia ochracea ochracea** Hodgson. Indian Rufous Piculet.

DUN : Hitaura : 3 ♀♀, 1 unsexed (May 11-24, June 4).

We found the Rufous Piculet to be rather rare in central Nepal, It was observed only on a few occasions in the lighter parts of forests in central dun. The present record appears to constitute the only one since Hodgson's time.

Measurements :

	Wing	Tail	Bill
3 ♀♀ :	52, 54 (2)	22, 23, 24	14, 14.5, 15
1 unsexed :	52	23	14.5

*328. **Jynx torquilla torquilla** Linnaeus. European Wryneck.

The European Wryneck was not found by us in Nepal, or by Scully (1879) or Ripley (1950b). Nor is there any mention of any Wryneck in the catalogue of Hodgson's earlier collection (Gray & Gray, 1846). The later catalogue (Gray, 1863) includes this species, and Hargitt (1890, p. 564) listed four Hodgson skins from Nepal. Proud (1955, p. 69) reported the species as a passage migrant in the Nepal Valley in September-October and March-April, but one cannot be sure as to the subspecies meant by her (see below, next form). Rand & Fleming (1957, p. 90) made the first definite record of this form from the tarai of western and eastern Nepal.

329. **Jynx torquilla chinensis** Hesse. Chinese Wryneck.

NEPAL VALLEY : Thankot : 2 ♂♂ (April 1, 9).

The Chinese Wryneck appeared rare in Nepal. These were the only specimens seen by us there.

Neither Scully (1879), nor Ripley (1950b), or Rand & Fleming (1957) reported this wryneck from Nepal. On the other hand, some of Hodgson's skins listed by Hargitt (1890, p. 564) may belong to this form. Similarly, Proud's record of the wryneck on passage in the Nepal Valley, as mentioned earlier (under the preceding form), may as well refer to the present subspecies.

Both my specimens are in moult. They have the wings worn, but central tail feathers still in moult. The April 1 bird has its body moult almost finished and that of April 9 probably so, but since the latter shows signs of soaking in water, obviously accidental, I am unable to say anything definite about it.

Vaurie (1959c, pp. 2-13) has recently discussed the question of the different recognizable subspecies of the species.

Measurements : 2 ♂♂ : Wing 86+, 88+ ; tail 67+, 69+ ; bill 18, 19.

Family Indicatoridae

Indicator xanthonotus xanthonotus Blyth. Himalayan Honeyguide.

Although Nepal lies within the range of the species, I am unable to trace any definite record of its occurrence there. Ripley's (1950b, p. 376) doubtful record based on hearsay evidence appears to be the only reference to this species in any Nepal list.]

(*To be continued*)

More Cyanophyceae of Hoshiarpur: I

BY

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(*With sixteen figures*)

In *J. Bombay nat. Hist. Soc.* **57**(3): 579-89 the author described 25 species belonging to ten genera. The present communication adds to our knowledge of the Cyanophyceae of Hoshiarpur and records 48 species belonging to 28 genera. It includes one new variety and seven new forms. The total number of species recorded from Hoshiarpur district thus comes to 73. This number is, however, not inclusive of the three new species, *Anabaena nathi* (Vasishta, 1960), *A. hoshiarpurensis* (Vasishta, 1960), and a new species of *Rivularia* (in the press).

SYSTEMATIC ENUMERATION OF THE SPECIES OBSERVED

Order CHROOCOCCALES Wettstein

Family CHROOCOCCACEAE Nägeli

MICROCYSTIS Kützing

1. **Microcystis flos-aquae** (Wittr.) Kirchner in Engler et Prantl, Natür. Pflanzenfam. I (1 a): 56, fig. 49 N, 1898; Forti in De Toni, Sylloge Algarum 5: 86, 1907; Crow in New Phytologist 22: 61, 1923; Frémy, Myxo. d'Afr. équat. franç. 19, fig. 16, 1929; Geitler, Kryptogamenflora, 138, fig. 59 e, f, 1932. *Microcystis aeruginosa* f. *flos-aquae* (Wittr.) Elenkin, Monogr. Algar. Cyano., pars spec. 1: 103, 1938. *Anacystis cyanea* (Kütz.) Drout & Daily, Butler Univ. Bot. Stud. 10: 221, 1952; Rev. Coccoid Myxophyceae 36, 1956 (p.p.).

Diameter cell=3.8-5.7 (-7) μ. Cells spherical, gas-vacuoles present.

Habitat: In a pond at village Sham Chaurasi, Hoshiarpur.

CHROOCOCCUS Näg.

2. **Chroococcus minutus** (Kütz.) Näg. Gatt. einzell. Algen 46, 1849; Geitler 232, figs. 112a, 113c, 1932; Desikachary, Cyanophyta 103, pl. 24, fig. 4, pl. 26, figs. 4, 15, 1959.

Diameter cell with sheath=8.5-11.9 μ, diameter cell without sheath=6.8-9.3 μ; diameter colony=upto 18.7 μ; crass. vag.=1.7 μ.

Habitat: In a permanent pond at village Nasrala, Hoshiarpur.

3. **Chroococcus minimus** (Keissler) Lemm. Ark. Bot. 2 (2) : 102, 1904 ; Geitler 232, 1932 ; Desikachary 106, 1959. *Chr. minutus* var. *minimus* Keissler in Zool. Bot. Ges. Wien 5 : 394, 1901 ; Forti 5 : 15, 1907.

Diameter cell with sheath=3.4-4.2 μ ; diameter cell without sheath=2.5-3μ; diameter colony=34 μ.

Habitat : In a permanent pond, among other algae, at village Nasrala, Hoshiarpur.

GLOEOCAPSA Kützing

4. **Gloeocapsa aeruginosa** (Carm.) Kütz. Phyc. Gene. 174, 1843 ; Phyc. Germ. 151, 1845 ; Tab. Phycologicae 1 : pl. 21, fig. 2, 1846 ; Species Algarum 218, 1849 ; Desikachary 115, 1959.

Diameter cell with sheath=4.7-5.7 μ; diameter cell without sheath=2.5-3 μ ; diameter colony=15.3-61.4 μ.

Habitat : Forming blue-green encrustation on the cemented sides of a water tank in Government College, Hoshiarpur.

5. **Gloeocapsa polydermatica** Kützing, loc. cit. 1 : 15, pl. 20, fig. 3, 1846 ; loc. cit. 208, 1849 ; Geitler 185, fig. 83 c, e, 1932 ; Desikachary 114, pl. 25, fig. 1, 1959.

Diameter cell with sheath=10.2-11 μ; diameter cell without sheath=3.4-5.1 μ ; crass. vag.=3.4 μ.

Habitat : On moist lawns of Government College, Hoshiarpur.

6. **Gloeocapsa pleurocapsoides** Novacek, Prace Morav. prir. Morav. Slezka Oddel, Bot. 7 : 1, 1929; Skuja, Susswasseralgenflora Burmens 17, pl. 1, figs. 3-5, 1949; Desikachary 118, pl. 24, fig. 3, 1959.

Diameter cell with sheath=10.2-11 μ; diameter cell without sheath=4.5-7.6 μ; crass. vag.=2-3.8 μ.

The sheath is coloured brown and the colonies may be more or less rounded or irregular, sheath lamellated. The Hoshiarpur alga possesses smaller dimensions than the type.

Habitat : Forming a dark brown growth on the sides of a pukka wall near railway crossing at Nasrala, Hoshiarpur.

GLOEOTHECE Näg.

7. **Gloeothece samoensis** Wille in Hedwigia 53 : 144, 1913 ; et in Rechinger, Bot. Zool. Ergebn. Samoa und Solomoninseln, Susswasseralgen 6, pl. 1, fig. 3, 1915 ; Geitler 219, 1932 ; Desikachary 128, pl. 23, fig. 3, 1959.

Long. cell with sheath=8.5-15.3 μ; long. cell without sheath=5.7-8.5 μ ; lat. cell with sheath=7.6-11.2 μ; lat. cell without sheath=4-4.7 μ.

Habitat : On moist soil, Hoshiarpur.

APHANOCAPSA Näg.

8. **Aphanocapsa montana** Cramer in Wartman et Schenk, Schweiz. Krypto. no. 134, 1862 ; Geitler 159, 1932 ; Desikachary 135, pl. 20, fig. 8, 1959.

Thallus shapeless, gelatinous, blue-green or yellow-green ; cells spherical, single or in pairs. Diameter cell=2.5-4 μ.

Habitat : Attached to the walls of a pukka drain, District Board, Hoshiarpur.

9. **Aphanocapsa biformis** A. Br. in Rabenhorst, Fl. Eur. Alg. 2 : 246, 1865 ; Geitler 158, fig. 70, 1932 ; Desikachary 134, pl. 21, figs. 3 & 4, 1959.

Thallus gelatinous, expanding, blue-green ; cells spherical, loosely arranged ; envelops distinct ; nannocytes present. Diameter cell=3.8-7 μ ; diameter nannocyte= 1.9-2 μ.

Habitat : At first attached, later free floating, in a semi-permanent pond along the railway track, Hoshiarpur.

APHANOTHECE Näg.

10. **Aphanothece stagnina** (Spreng.) A. Br. loc. cit. 2 : 66, 1865 ; Geitler 164, figs. 72, 75, a, b, 1932 ; Desikachary 137, pl. 22, fig. 10, 1959.

Thallus, solid, gelatinous, light blue-green, 2.5 cm. in diameter, often impregnated with calcareous crystals ; cells oblong, ovoid or cylindrical, individual envelops indistinct. Lat. cell=3.8-5.7 μ ; long. cell=7.6-11 μ.

Habitat : Attached to the plants of *Chara* in a pond along the sides of railway track, Hoshiarpur.

MERISMOPEDIA Meyen

11. **Merismopedia glauca** (Ehrenb.) Näg. Gatt. einzell. Algen 55, pl. 1D, fig. 1, 1849 ; Geitler 264, fig. 129d, 1932 ; Desikachary 155, pl. 29, fig. 5, 1959.

Lat. cell=3.4-5.7 μ ; long. cell=3.4-5.7 μ; lat. colony=38.4-76.8 μ. There are sixteen to one hundred and fifty cells in a colony.

Habitat : Along the sides of an irrigation channel passing through village Rehana, Hoshiarpur.

DACTYLOCOCCOPSIS Hansgirg

12. **Dactylococcopsis raphidioides** Hansg. in Syn. Gen. Myxo. Notarisia 590, 1888 ; Geitler 281, fig. 137, 1932 ; Desikachary 158, pl. 29, figs. 1, 2, 1959.

var. **major** var. nov. (Fig. 1)

Cellulae fusiformes, falcatae, sigmoideae vel lunae instar curvatae ; occurrunt singulae, 1.9-3.5 μ latae, 11.5-60. μ longae. Typus lectus mense aprili, die 30, 1960, et positus in Hoshiarpur herbario in collegio Gubernii sub numero *Vasishta* 2.

Cells spindle-shaped, sickle-shaped, sigmoid or lunately bent, 1.9-3.5 μ broad and 11.5-60.5 μ long, occurring singly.

Habitat : On the filaments of *Spirogyra* from a roadside pond, Phagwara road, Hoshiarpur.

The type of the variety was collected on 30.4.60 and has been deposited in the form of camera lucida drawings in Government College, Hoshiarpur Herbarium under reference number *Vasishta* 2.

The variety resembles the type in the shape and occurrence of the cells ; but differs in the dimensions of the cells. The cells in the Hoshiarpur alga are very long. Rao (1937b, 347) reported a form from Benares with cells upto 40 μ long but in the present form the cells are as long as 60.5 μ.

Order CHAMAESIPHONALES Wettstein

Family DERMOCARPACEAE Geitler

DERMOCARPA Crouan

13. **Dermocarpa sphaerica** Setchell et Gardner in Gardner, Univ. Calif. Publ. Bot. 6 : 457, pl. 39, fig. 14, 1918 ; Geitler 393, fig. 217, 1932 ; Desikachary 174, 1959.

Sporangia single or in groups, light blue-green, spherical ; sheath distinct, hyaline ; endospores liberated by the gelatinisation of the sporangial wall.

Diameter sporangium=8.5-18.7 μ ; diameter spore=2.5-3.4 μ.

Habitat : Epiphytic on the filaments of *Cladophora* in a tank in Govt. College, Hoshiarpur.

Order NOSTOCALES Geitler

Family Oscillatoriaceae Kirchner

ARTHROSPIRA Stizenberger

14. **Arthrospira khannae** Drouet et Strickland in Drouet, Field Mus. nat. Hist. Bot. 20 (6) : 141, pl. 1, fig. 6, 1942 ; Desikachary 189, pl. 35, fig. 12, 1959.

Trichomes blue-green, free floating, loosely spirally coiled, unconstricted, attenuated at the ends ; cross-walls granulated, gas-vacuoles present in the cells. Lat. trichome=3.8-5.1 μ ; long. cell=1.9-2.5 μ ; breadth of the spiral=19.2 μ ; distance between spirals=20 μ.

Habitat : Planktonic in a roadside pond, Phagwara road, Hoshiarpur.

SPIRULINA Turpin ex Gardner

15. **Spirulina princeps** W. et G. S. West in Trans. Linn. Soc. (Lond.) Bot., 2 ser., 6 : 205, 1902 ; Geitler 931, fig. 593 d, 1932 ; Desikachary 197, pl. 36, fig. 7, 1959.

Lat. trichome=3.8-5.7 μ ; spirals 7.6-8.5 μ broad and 9.5-11.5 μ distant.

Habitat : In a stagnant water pond, Phagwara road, Hoshiarpur.

OSCILLATORIA Vaucher

16. **Oscillatoria salina** Biswas in Jour. Dept. Sci. Calcutta Univ. 8 : 21, pl. 6, fig. 6 a-d, 1926 ; Geitler 978, fig. 624, 1932 ; Desikachary 239, 1959.

Lat. cell=3.8-4.7 μ ; long. cell=1.7-2.7 μ.

Habitat : Forming deep blue, thin, membranous thallus extending over the bottom of a temporary roadside pond, Phagwara road, Hoshiarpur.

17. **Oscillatoria agardhii** Gomont, Mon. Oscill. 205, 1892 ; Geitler 974, figs. 618, 621, 1932 ; Desikachary 235, 1959.

Long. trichome=upto 268 μ ; lat. trichome=4.7-6.6 μ ; lat. trichome at apex= 3.8 μ ; long. cell=1.9-3 μ.

Habitat : In a pond at village Sham Chaurási, Hoshiarpur. It was found mixed with *Microcystis flos-aquae.*

18. **Oscillatoria proteus** Skuja in Nov. Acta Reg. Soc. Upsal., ser. IV, 14 : 48, pl. 8, figs. 11-13, 1949 ; Desikachary 221, pl. 41, figs. 15, 16, 18, 1959.

Lat. trichome=5.7-7.6 μ ; long. cell=2.5-3.5 μ.

Habitat : Planktonic among other algae in a pond at Guru Nanak Nagar, Hoshiarpur.

19. **Oscillatoria limosa** Ag. ex Gomont ; Agardh, Disp. Alg. Suec. 35, 1812 ; Gomont, loc. cit. 210, pl. 6, fig. 13, 1892 ; Geitler 944, fig. 598 d, 1932 ; Desikachary 206, pl. 42, fig. 11, 1959.

Lat. trichome=16.8-18.7 μ ; long. cell=3.7-5.6 μ.

Habitat : In the stagnant water of a pond, Hoshiarpur.

20. **Oscillatoria sancta** (Kütz.) Gomont, loc. cit. 209, pl. 6, fig. 13, 1892 ; Geitler 944, fig. 598 d, 1932 ; Desikachary 203, pl. 42, fig. 10, 1959.

Lat. cell=13.1-15 μ ; long. cell=2-3.7 μ.

Habitat : Forming dark brown gelatinous growth on a moist wall in Government College, Hoshiarpur.

forma . . . Rao, in Proc. Indian Acad. Sci. B, 6 (6) : 366, 1937 b.

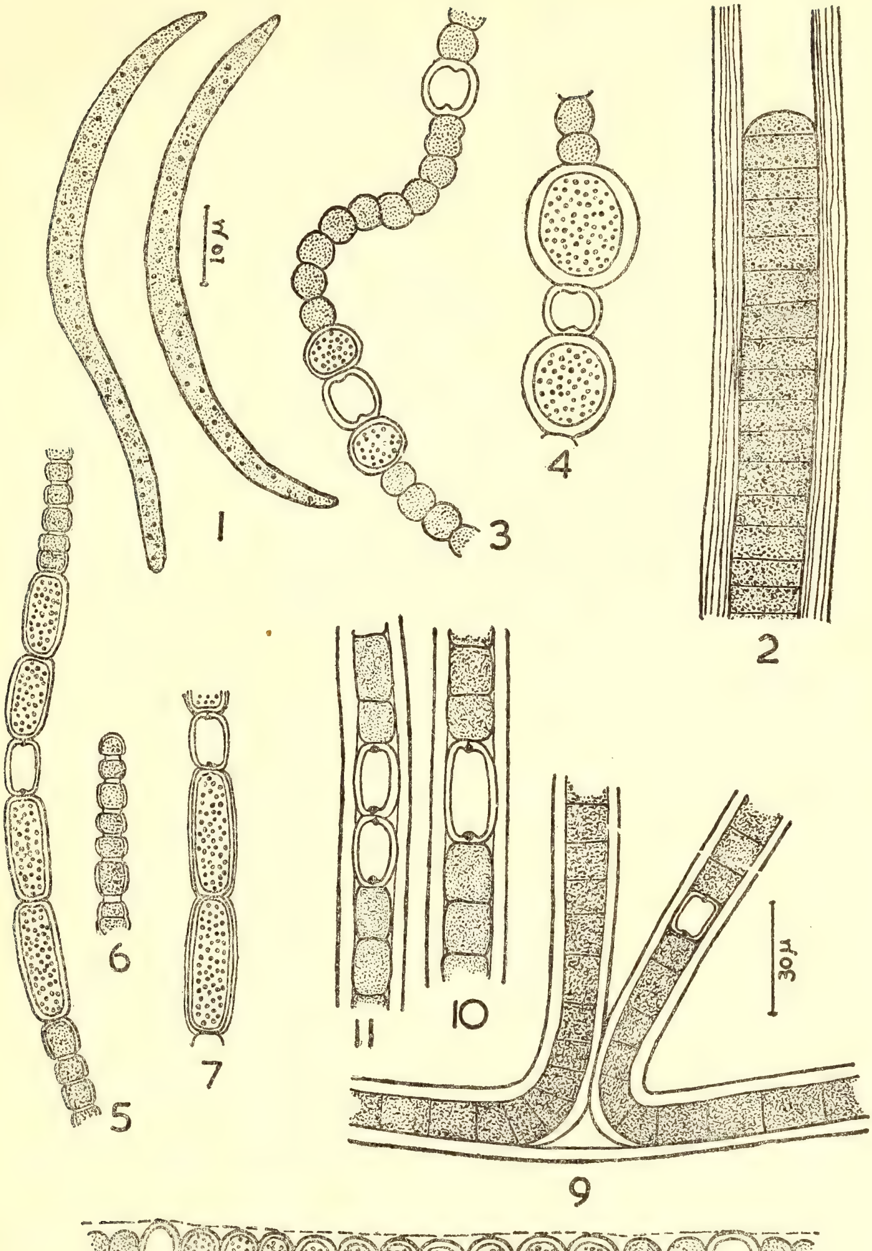
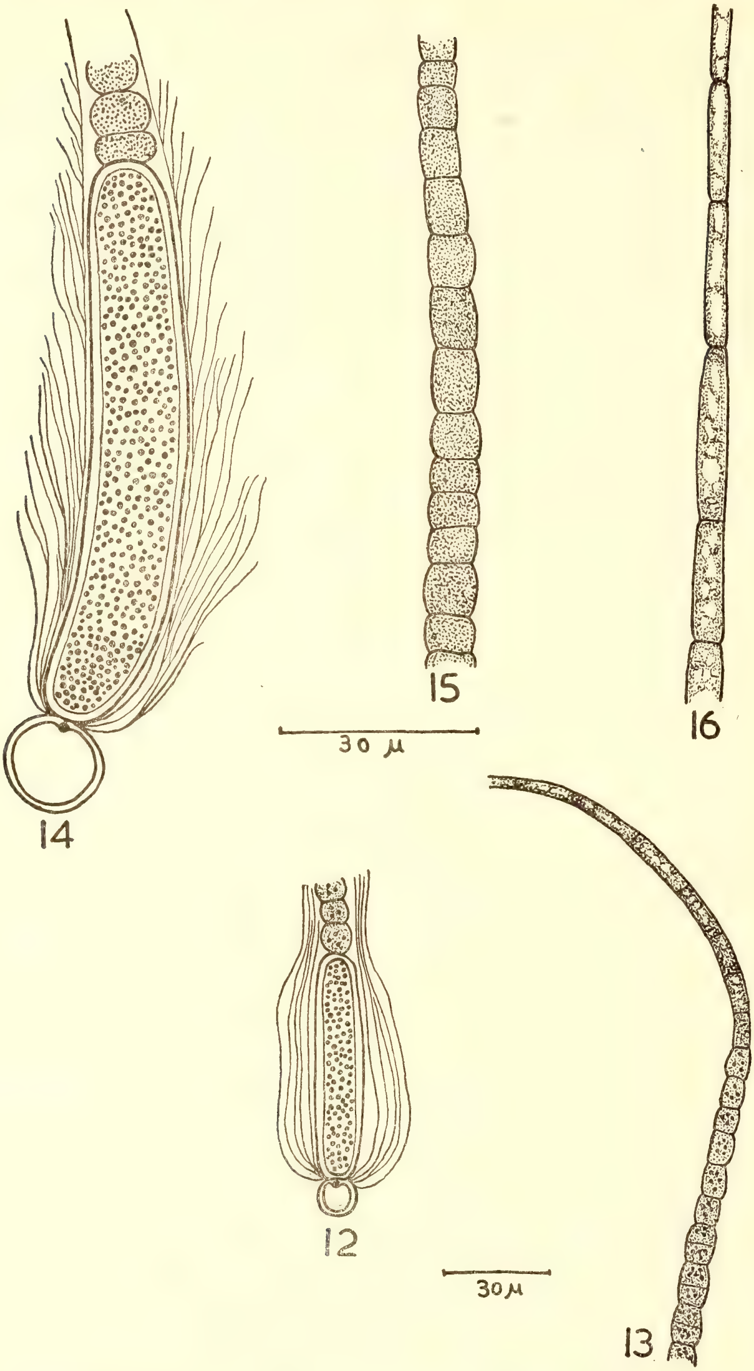


Fig. 1. *Dactylococcopsis raphidioides* var. *major* var. nov. Showing two cells. Fig. 2. *Lyngbya aestuarii* var. *arbustiva* Brühl et Biswas. Showing portion of a filament. Figs. 3 & 4. *Anabaena sphaerica* forma *major* f. nov.; fig. 3. Portion of a trichome with young spores; fig. 4. portion of a trichome with matuce spores. Figs. 5-7. *Anabaena oscillarioides* forma *minor* f. nov.; figs. 5 & 7. Portions of trichomes with spores; fig. 6. part of a trichome with end cell. Fig. 8. *Nodularia spumigena* Mertens var. *major* (Kütz.) Born. et Flah. Part of a fertile filament. Figs. 9-11. *Scytonema simplex* forma *major* f. nov.; fig. 9. Portion of the filament with false branches; fig. 10. portion of the filament with one heterocyst; fig. 11. portion of the filament with two heterocysts.



Figs. 12 & 13. *Gloeotrichia raciborskii* var. *kashiense* Rao, forma *intermedia* f. nov. Fig. 12. Basal part of the trichome showing heterocyst, spore, and the thick sheath ; fig. 13. Upper part of the filament with a portion of the hair. Figs. 14 - 16. *Gloeotrichia raciborskii* forma *hoshiarpurensis* f. nov. Fig. 14. Basal part of the filament ; fig. 15. Upper part of filament ; fig. 16. Portion of the hair.

Lat. trichome=9.2-11.2 μ; long. cell=2-4 μ. The specimen had no constrictions at the joints.

Habitat : On the bottom mud of a roadside pond, Phagwara road, Hoshiarpur.

PHORMIDIUM Kütz.

21. **Phormidium valderianum** (Delp.) Gomont, loc. cit. 167, pl. 4, fig. 20, 1892 ; Geitler 1011, fig. 645 c, 1932 ; Desikachary 263, pl. 44, fig. 5, 1959.

Lat. trichome=2-2.5 μ ; long. cell=3.4-6.6 μ.

Habitat : Forming a thick and expanded, dull green growth on the sides of a pukka drain, district board, Hoshiarpur.

22. **Phormidium luridum** (Kütz.) Gomont, loc. cit. 165, pl. 4, figs. 17, 18, 1892 ; Geitler 1009, fig. 645 a, 1932 ; Desikachary 263, 1959.

Lat. trichome=1.7-2 μ ; long. cell=2.5-5.1 μ.

Habitat : On the sides of a water tank, Botanical Garden, Government College, Hoshiarpur.

23. **Phormidium purpurascens** (Kütz.) Gomont, loc. cit. 166, pl. 4, fig. 19, 1892 ; Geitler 1009, fig. 644 c, 1932 ; Desikachary 262, pl. 44, fig. 4 & pl. 45, figs. 1-4, 1959.

Lat. trichome=1.7-2.5 μ ; long. cell=2.5-5.1 μ ; crass. vag.=0.5 μ.

Habitat : Forming brownish violet, leathery and compact thallus on the sides of a water tap, Hoshiarpur.

LYNGBYA Ag.

24. **Lyngbya aerugineo-caerulea** (Kütz.) Gomont, loc. cit. 146, pl. 4, figs. 1-3, 1892 ; Geitler 1062, fig. 670, 1932 ; Desikachary 315, pl. 48, fig. 9, 1959.

Lat. filament=5.9-6.8 μ ; lat. trichome=5.1-6.6 μ ; long. cell=4.2-5.1 μ.

Habitat : On moist soil, Hoshiarpur.

25. **Lyngbya aestuarii** Liebem. ex Gomont. Liebemann, Bermerk. Till. danske Algefl. Kroyera Tidsskr. 492, 1841 ; Gomont, loc. cit. 127, pl. 3, figs. 1, 2, 1892 ; Geitler 1052, fig. 666, 1932 ; Desikachary 305, pl. 52, fig. 8, 1959.

Lat. filament=15.3-16 μ ; lat. trichome=10.7-11.5 μ ; long. cell=3-4.7 μ ; crass. vag.=1.7 μ.

Habitat : Planktonic in a roadside pond, Phagwara road, Hoshiarpur.

Var. **arbustiva** Brühl et Biswas in Journ. Dept. Sci. Calcutta Univ. 5 : 5, pl. 2, figs. 9a-c, 1923. (Fig. 2)

Lat. filament=17-24 μ ; lat. trichome=9.5-15.3 μ ; long. cell= 4-10μ ; crass. vag. =2-5 μ.

Habitat : On moist kacha walls of houses at village Purhiran, Hoshiarpur. Inner layers of the sheath are coloured reddish brown.

26. **Lyngbya putealis** Mont. ex Gomont. Montagne in Ann. Sci. nat., 2 ser., Bot. 13 : 200, 1840 ; Gomont, loc. cit., 143, pl. 3, fig. 14, 1892 ; Geitler 1063, fig. 675, 1932 ; Desikachary 317, pl. 52, fig. 12, 1959.

Lat. filament=8-11.5 μ ; lat. trichome=5.7-7.6 μ ; long. cell=3.8-7.6 μ ; crass. vag.=1.9 μ.

Habitat : Mixed with *Lyngbya aestuarii* in a stagnant water pond, Phagwara road, Hoshiarpur.

27. **Lyngbya major** Menegh. ex Gomont apud Meneghini, Consp. Algol. Eugan. 12, 1837 ; Gomont, loc. cit. 144, pl. 3, fig. 15, 1892 ; Geitler 1066, fig. 679 a, 1932 ; Desikachary 320, pl. 52, fig. 11, 1959.

Lat. filament=15.3-19.2 μ; lat. trichome=11.5-13.4 μ; long. cell=1.9-2.8 μ; crass. vag.=1.9-2.5 μ. The cells contain gas-vacuoles.

Habitat: In a stagnant water pond, Phagwara road, Hoshiarpur; mixed with *Lyngbya putealis* and *Lyngbya aestuarii*.

28. **Lyngbya hieronymusii** Lemm. Forschbers. Plon 12: 146, pl. 4, figs. 12, 13, 1905; Kryptog. Mark Brandenb. 3 : 139, fig. 6 (p. 102), 1910 ; Geitler 1047, fig. 656 a, 1932 ; Desikachary 297, pl. 48, fig. 4, 1959.

Lat. filament=12-15.3 μ ; lat. trichome=11.5-13.4 μ ; long. cell=2.5-4 μ.

Habitat: In a roadside pond, Phagwara road, Hoshiarpur.

SCHIZOTHRIX Kütz.

29. **Schizothrix lateritia** (Kütz.) Gomont, loc. cit. 308, pl. 8, fig. 4, 1892 ; Geitler 1081, fig. 691, 1932 ; Desikachary 326, 1959.

Lat. filament=upto 26.8 μ ; lat. trichome=1.7 μ ; long. cell=2-5 μ.

Habitat: Forming greyish green or flesh-coloured leathery growth at the bottom and sides of a cemented tank in the Botanical Garden, Govt. College, Hoshiarpur.

The filaments are branched and thickly packed ; sheath broad and uneven, becoming pointed at the ends.

MICROCOLEUS Desmaz.

30. **Microcoleus paludosus** (Kütz.) Gomont, loc. cit. 358, pl. 14, fig. 13, 1892 ; Geitler 1144, fig. 753, 1932 ; Desikachary 344, pl. 56, fig. 2, 1959.

Lat. filament=upto 57.6 μ ; lat. trichome=4.7-6.6 μ ; long. cell=3.8-12.4 μ.

Habitat: Forming dark blue-green stratum on the kacha walls of houses in village Purhiran, Hoshiarpur.

31. **Microcoleus lacustris** (Rabenh.) Farlow in Alg. Am. Bor. nr. 227 bis, 1877 ; Gomont, loc. cit., 359, 1892 ; Geitler 1142, figs. 749, 750 a, 1932 ; Desikachary 345, pl. 60, figs. 4, 5, 1959.

forma **intermedia** f. nov.

Thallus caeruleo-viridis ; filamenta irregulariter curvata, 34.5-45.1 μ lata, vagina hyalina, nonnumquam mucosa evadens ; trichomata constricta ad septa ; cellulae cylindricae, 3 μ latae, 6.6-11.5 μ longae, cellula terminali conica; calyptra nulla. Typus lectus mense februario, die 10, 1960, et positus in Hoshiarpur herbario collegii Gubernii sub numero *Vasishta* 3.

Thallus blue-green, filaments irregularly curved, sheath colourless, sometimes gelatinising ; trichomes constricted at septa ; cells cylindrical, end cell conical ; calyptra absent. Lat. filament=34.5-45.1 μ, lat. trichome=3 μ ; long. cell=6.6-11.5 μ ; lat. terminal cell=2.7 μ ; long. terminal cell=11.5-13.4 μ.

Habitat: Forming a blue-green growth on moist soil along a water course at Chak Saidu, Hoshiarpur, 10.2.1960.

Type specimen deposited in the herbarium, Government College, Hoshiarpur under reference number *Vasishta* 3.

The Hoshiarpur alga differs from the type in possessing narrower trichomes and resembles in this respect forma *minor* nom. nov.=*Microcoleus lacustris* forma . . . Rao, C. S. (1940, 131) ; but differs from forma *minor* in possessing much longer cells. Length of cells brings this form close to the type.

32. **Microcoleus chthonoplastes** Thuret ex Gomont. Thuret in Ann. Sci. nat. Bot. 6th ser. 1 : 378, 1875 ; Gomont, loc. cit., 353, pl. 14, figs. 5-8, 1892 ; Geitler 1136, fig. 741, 1932 ; Desikachary 343, pl. 60, figs. 7-9, 1959.

Lat. filament=26.8-46 μ; lat. trichome=3.8-6.6 μ; long. cell=3.8-11.2 μ; lat. apical cell=3.8 μ; long. apical cell=11.5 μ.

Habitat : Forming dark green growth on the moist lawns of Government College, Hoshiarpur.

Family NOSTOCACEAE Kützing

Sub-family ANABAENOIDEAE Born. et Flah.

CYLINDROSPERMUM Kützing

33. **Cylindrospermum musicola** Kützing ex Born. et Flah. Kützing, loc. cit. 173, 1845 et 1 : 53, pl. 98, fig. 1, 1849 ; Born. et Flah., Revis. Nostocac. Hétéroc. 254, 1888; Geitler 822, fig. 520d, 1932 ; Desikachary 366, pl. 65, fig. 3, 1959.

forma **hoshiarpurense** f. nov.

Thallus caeruleo-viridis, mucilaginosus ; trichomata constricta ad septa, 3.8-4.2 μ lata ; cellulae cylindricae, 3.8-5.1 μ longae; heterocysta oblonga, 4.7-5.7μ lata, 4.7-7.6 μ longa; sporae ovales, 9.5-15.3 μ latae, 19.2-32.6 μ longae, episporio levi, luteolo-brunneo. Typus lectus mense maio 3, 1960, et positus in Hoshiarpur herbario collegii Gubernii sub numero *Vasishta* 4.

Thallus blue-green, mucilaginous ; trichomes constricted at cross walls ; cells cylindrical ; heterocysts oblong ; spores oval, epispore smooth, yellowish brown. Lat. trichome=3.8-4.2 μ; long. cell=3.8-5.1 μ; lat. heterocyst=4.7-5.7 μ; long. heterocyst=4.7-7.6 μ; lat. spore=9.5-15.3 μ; long. spore=19.2-32.6 μ.

Habitat : Forming blue-green irregular patches on moist soil of lawns in Government College, Hoshiarpur. Collected on May 3, 1960.

The type of this form has been deposited in Government College, Hoshiarpur Herbarium under reference number *Vasishta* 4.

The form resembles the type in the dimensions of the cells and the heterocysts ; but differs in the dimensions of the spores. It also differs from var. *longispora* Dixit (1936, 100) in possessing (*a*) smaller dimensions of heterocysts, (*b*) cells smaller in length, and (*c*) spores much broader and slightly longer.

WOLLEA Born. et Flah.

34. **Wollea bharadwajae** Singh in Ann. Bot. Lond., n.s., 6 : 593-606, 1942 ; Desikachary 372, pl. 66, figs. 1-18, 1959.

Long. thallus=3-4 cm. ; lat. thallus=2-2.5 mm. ; lat. trichome=3.7-5.6 μ; long. cell=3.7-4.6 μ; lat. heterocyst=5.6-6.6 μ; long. heterocyst=5.6-7.5 μ; lat. spore=8.4-12.1 μ; long. spore=11.2-13.4 μ.

Habitat : Free floating or attached to submerged water plants or bottom of ponds, Guru Nanak Nagar, Hoshiarpur.

The material was collected by Prof. B. R. Vasishta, formerly Head of the Botany Department, Government College, Hoshiarpur.

NOSTOC Vaucher

35. **Nostoc maculiforme** Born. et Flah. loc. cit. 189, 1888 ; Desikachary 374, 1959.

Lat. trichome=3.8-4 μ; long. cell=3.8-4 μ; lat. heterocyst=4-5.7 μ; long. heterocyst=3.8-5.7 μ; diameter spore=7.6 μ.

Habitat : Attached to dead twigs submerged in water in a roadside pond near village Purhiran, Hoshiarpur.

36. **Nostoc muscorum** Ag. ex Born. et Flah. Agardh, loc. cit. 44, 1812 ; Born. et Flah. loc. cit. 200, 1888 ; Geitler 844, fig. 535, 1932 ; Desikachary 385, pl. 70, fig. 2, 1959.

Lat. trichome=3.8-4.7 μ; long. cell=3.8-9.5 μ; lat. heterocyst=5.7-7.6 μ ; long. heterocyst=5.7-7.6 μ ; lat. spore=4.7-8 μ ; long. spore=6.6-11.5 μ.

Habitat : On moist soil near village Purhiran, Hoshiarpur.

ANABAENA Bory

37. **Anabaena sphaerica** Born. et Flah. loc. cit. 288, 1888 ; Geitler 878, 1932 ; Desikachary 393, 1959.

forma **major** f. nov. (Figs. 3 and 4)

Thallus floccosus, gelatinosus ; trichomata irregulariter curvata et intertexta, attenuata ad apices, 3.7-6.5 μ lata ; cellula terminalis rotundata ; cellulae sphaericae vel doliiformes, 4-7.5 μ longae, pseudovacuolis nullis; heterocysta intercalaria, doliiformia, 7.5-8.5 μ lata, 7.5-11.2 μ longa ; sporae uni vel utrique lateri hetericystorum adhaerentes, sub-sphaericae vel ovales, 9.5-17μ latae, 10-19.5 μ longae, episporio levi, crasissimo, luteolo-brunneo. Typus lectus mense septembri 10, 1959 et positus in Hoshiarpur herbario collegii Gubernii sub numero *Vasishta* 5.

Thallus floccose, gelatinous, free floating, blue-green ; trichomes irregularly curved and entangled, attenuated at the apices ; end cell rounded ; cells spherical or barrel-shaped, pseudovacuoles absent ; heterocysts intercalary, barrel-shaped ; spores on one or both sides of the heterocysts, sub-spherical to oval, epispore smooth, very thick, yellowish brown. Lat. trichome=3.7-6.5 μ ; long. cell=4-7.5 μ ; lat. heterocyst=7.5-8.5 μ ; long. heterocyst=7.5-11.2 μ; lat. spore=9.5-17 μ; long. spore=10-19.5μ.

Habitat : In stagnant water of a pond, Phagwara road, Hoshiarpur. Collected on September 10, 1959.

Type deposited in Government College, Hoshiarpur Herbarium under reference number *Vasishta* 5.

The form resembles the type in the shape of cells, heterocysts and spores ; but differs from it in the dimensions of the cells, heterocysts and spores. The spores in the present form have greater dimensions.

38. **Anabaena oscillarioides** Bory ex Born. et Flah. in Rev. Nost. Heter. 233, 1888; Geitler 886, fig. 567 e, 1932 ; Desikachary 417, pl. 71, fig. 7, 1959.

forma **major** f. nov. (Figs. 5-7)

Plantae floccosae, libere natantes, caeruleo-virides ; trichomata recta vel irregulariter curvata ; cellulae doliiformes, 4-5.2 μ latae, aeque longae ac latae vel paulo breviores vel longiores quam latae, 3.7-7.5 μ longae; heterocysta cylindrica, 5.6-7.5 μ lata, 7.5-10.5 μ longa, tenuiter applanata ad apices ; sporae cylindricae, 6.5-9.3 μ latae, 15-26.2 μ longae, singulae vel in breves series dispositae in utroque latere heterocystorum, circumdatae vagina speciali mucosa, episporio levi, luteolo-brunneo in sporis maturis. Typus lectus mense februario 1, 1960 et positus in Hoshiarpur herbario collegii Gubernii sub numero *Vasishta* 6.

Plant mass floccose, free floating, blue-green ; trichomes straight or irregularly curved ; cells barrel-shaped, as long as broad or slightly shorter or longer than broad ; heterocysts cylindrical, slightly flattened at the ends ; spores cylindrical, single or in short series on either side of the heterocyst surrounded by a special mucilaginous. sheath, epispore smooth, yellowish brown in mature spores. Lat. trichome=4-5.2 μ; long. cell=3.7-7.5 μ ; lat. heterocyst=5.6-7.5 μ; long. heterocyst=7.5-10.5 μ ; lat. spore=6.5-9.3 μ ; long. spore=15-26.2 μ.

Habitat : Free floating in a stagnant water pond situated on Phagwara road, Hoshiarpur. Collected on February 1, 1960.

The type of this form is deposited in Government College, Hoshiarpur Herbarium under reference number *Vasishta* 6.

NODULARIA Mertens

39. **Nodularia spumigena** Mertens in Born. et Flah. loc. cit. 245, 1888 ; Geitler 866, fig. 554 b, c, 1932 ; Desikachary 423, pl. 80, figs. 13, 14, 1959. Var. **major** (Kütz.) Born. et Flah. loc. cit. 247, 1888 ; Geitler 867, 1932 ; Desikachary 424, pl. 61, fig. 12, 1959. (Fig. 8)

Lat. filament=12-15.3 μ; lat. trichome=11.5-12.4 μ; long. cell=4-6 μ; lat. heterocyst=13.5-17 μ; long. heterocyst=7.5-8 μ; lat. spore=11.5-18 μ ; long. spore=6-7.6 μ.

Habitat : Free floating in the stagnant water of a roadside pond, Phagwara road, Hoshiarpur.

The Hoshiarpur specimen of the alga possesses greater dimensions of the spores.

AULOSIRA Kirchner

40. **Aulosira fertilissima** Ghose in Jour. Linn. Soc. Bot. 46 : 342, pl. 31, fig. 9, 1923 ; Geitler 675, fig. 435, 1932 ; Desikachary 431, pl. 80, fig. 6, 1959. Var. **tenuis** Rao in Proc. Indian Acad. Sci. B 6 : 353, fig. 3 F-I, 1937 b ; Desikachary 431, pl. 80, figs. 2-5, 1959.

Lat. filament=6.6-7.6 μ; lat. trichome=3.8-4.7 μ; long. cell=11.5-19.2 μ; lat. heterocyst=4.7-7.6 μ ; long. heterocyst=7.6-19.2 μ ; lat. spore=4.7-11.5 μ; long. spore=11.5-19.2 μ.

Habitat : Forming yellowish brown to greyish blue, fibrous plant mass floating on the surface of water or attached to other objects in a semi-permanent pond near railway crossing at village Nasrala, Hoshiarpur.

Family SCYTONEMATACEAE Rabenh.

SCYTONEMA Agardh

41. **Scytonema simplex** Bharadwaja in Rev. Algol. Paris 7 : 157, fig. 1 A, B, 1934 ; Desikachary 455, pl. 89, fig. 1, 1959.

forma **major** f. nov. (Figs. 9-11)

Thallus crassus, caeruleo-viridis vel luteolo-caeruleo-viridis; filamenta irregulariter curvata, 15.3-19.2 μ lata ; vaginae firmae, hyalinae ; cellulae cylindricae, 8.5-11.5 μ latae, 7.6-26.8 μ longae; heterocysta singula vel bina, cylindrica, 9.5-11.5 μ lata, 15.3-38.4 μ longa. Typus lectus mense novembri 23, 1959 et positus in Hoshiarpur herbario collegii Gubernii sub numero *Vasishta* 7.

Thallus thick, blue-green to yellowish blue-green ; filaments irregularly curved; sheath thick, firm, hyaline ; cells cylindrical ; heterocysts single or in pairs, cylindrical. Lat. filament=15.3-19.2 μ ; crass. vag.=3.8 μ; lat. trichome=8.5-11.5 μ; long. cell=7.6-26.8 μ ; lat. heterocyst=9.5-11.5 μ ; long. heterocyst=15.3-38.4 μ.

Habitat : Forming dirty blue-green thallus, floating freely on the surface of a stagnant water pond near railway crossing at village Nasrala, Hoshiarpur. Collected on November 23, 1959.

The type of this form is deposited in Government College, Hoshiarpur Herbarium under reference number *Vasishta* 7.

This form differs from the type in possessing broader filaments.

TOLYPOTHRIX Kützing

42. **Tolypothrix crassa** West et West loc. cit. 35 : 267, 1897 ; Geitler 740, 1932 ; Desikachary 504, 1959.

Lat. filament=18.7-21.2μ; crass. vag.=1.7-3.4 μ; lat. trichome=15.3 μ ; long. cell =6.8-12.7 μ ; lat. heterocyst=15.3 μ ; long. heterocyst=15.3 μ.

Habitat : On the trunk of a palm tree, mixed with *Lyngbya palmarum* and *Tolypothrix campylonemoides*, in Government College, Hoshiarpur.

43. **Tolypothrix campylonemoides** Ghose loc. cit. 46 : 344, pl. 13, fig. 12, 1923 ; Geitler 726, fig. 467, 1932 ; Desikachary 502, pl. 95, fig. 5, 1959.

Lat. filament=11.5-12.1 μ; lat. trichome=7.6-9.5 μ ; long. cell=3.8-5.7 μ; lat. heterocyst=11.5 μ ; long. heterocyst=7.6-9.5 μ.

Habitat : On a palm tree, mixed with *Lyngbya palmarum* and *Tolypothrix crassa*, in Government College, Hoshiarpur.

Family Rivulariaceae Rabenhorst

HOMOEOTHRIX (Thuret) Kirchner

44. **Homoeothrix juliana** (Menegh.) Kirchner loc. cit. 1 a, 348, 1898 ; Geitler 575, fig. 359, 1932 ; Desikachary 519, pl. 107, fig. 7, 1959. *Calothrix juliana* (Menegh.) Born. et Flah. loc. cit. 348, 1886. *Leibleinia juliana* Kütz. in Bot. Zeit. 194, 1847.

Filaments erect, single or in clusters, forming an olive coloured velvety thallus, unbranched ; sheath thin, firm, colourless, un-lamellated ; trichomes produced into a prominent hair ; cells discoid ; reproduction by hormogone formation ; heterocysts absent. Lat. filament=11.5-15.3 μ ; lat. trichome=9.5-11.5 μ ; long. cell=3.8-7.6 μ ; lat. hair=3.8 μ at top and 7.6 μ below ; long. cell in hair=11.5-26.8 μ.

Habitat : Forming an olive-coloured thallus on the sides of a water tank in Botanical Gardens, Government College, Hoshiarpur. Sometimes mixed with *Calothrix parietina*.

CALOTHRIX Ag.

45. **Calothrix braunii** (A.Br.) Born. et Flah. loc. cit. 368, 1886 ; Geitler 606, fig. 381, 1932 ; Desikachary 535, pl. 114, fig. 3, 1959.

Lat. filament=10.2 μ; lat. filament above=8.5 μ ; lat. trichome=6.8-7 μ ; long. cell=3.8-4.2 μ ; crass. vag.=0.85 μ ; lat. heterocyst=7-7.6 μ ; long. heterocyst= 6.6-7.2 μ.

Habitat : Forming a blue-green, caespitose thallus on moist soil of a crop field, Hoshiarpur.

46. **Calothrix parietina** Thuret ex Born. et Flah. Thuret in Ann. Sci. nat. Bot., ser. 6, 1 : 381, 1875 ; Born. et Flah. loc. cit. 366, 1886 ; Geitler 604, fig. 380, 1932 ; Desikachary 538, pl. 108, figs. 6-8, pl. 115, fig. 1, 1959. *Mastichonema caespitosum* Kütz. Phyc. Germ. 184, 1845.

Lat. filament=11.5-15.3 μ; lat. trichome=5.7-9.5 μ; long. cell at base=3.8-4.2 μ; long. cell above=4.2-6.7 μ ; lat. heterocyst=11.5 μ ; long. heterocyst=7.6 μ. Sheath lamellated and coloured brown.

Habitat : Forming a dark brown and expanded growth on the cemented sides of a tank in Botanical Gardens, Government College, Hoshiarpur.

GLOEOTRICHIA Ag.

47. **Gloeotrichia raciborskii** Wolosz. var. **kashiense** Rao in Proc. Indian Acad. Sci., B, 6 : 351, figs. 3 A-E, 1937 b ; Desikachary 563, pl. 117, figs. 2-6, 1959.

forma **intermedia** f. nov. (Figs. 12-13)

Thallus magnus 1-2.5 cm. diam. luteolo-brunneus; trichomata constricta, 7.6-9.6 μ lata in regione basali, 2.7-3.4 μ lata in regione capilli; cellulae 3.8-7.6 μ longae, 13.4-30.7 μ longae in regione capilli; heterocysta sphaerica, 9.6-11.5 μ diam.; sporae ellipsoideae, 11.5-15.3 μ latae, 30.7-61.4 μ longae, episporio levi, hyalino; vagina crassa et brunnea, 7.6-11.5 μ lata in regione basali. Typus lectus mense februario 15, 1960, et positus in Hoshiarpur herbario collegii Gubernii sub numero *Vasishta* 8.

Thallus large, 1-2.5 cm. diameter, yellowish brown ; trichomes constricted; heterocysts spherical ; spores ellipsoidal, epispore smooth, hyaline ; sheath thick and brown.

Lat. trichome at base=7.6-9.6 μ; lat. trichome above=3.8-5.7 μ ; long. cell=3.8-7.6 μ ; lat. hair=2.7-3.4 μ; long. cell in hair=13.4-30.7 μ ; diameter heterocyst=9.6-11.5 μ; lat. spore=11.5-15.3 μ ; long. spore=30.7-61.4 μ ; lat. sheath at base=7.6-11.5 μ.

Habitat : Attached to other submerged plants in a roadside pond, Jullundhur road, near village Nasrala, Hoshiarpur. Collected on February 15, 1960. The type is deposited in Government College, Hoshiarpur herbarium under reference number *Vasishta* 8.

The form resembles the variety in the dimensions of the spores and shape of cells and heterocysts ; but differs in the dimensions of the cells and thallus.

It resembles variety *longispora* Rao, (1939, 146) in the dimensions and shape of cells, heterocysts and thallus ; but differs in the dimensions of the spores. The Hoshiarpur form is intermediate between the varieties *kashiense* and *longispora*.

forma **hoshiarpurensis** f. nov. (Figs. 14-16)

Thallus parvus, 1-2.5 mm. diam. luteolo-brunneus; trichomata constricta, desinentia in capillum longum, 7.6-11.5 μ lata in regione basali; vagina basalis crassa et brunnea, 3.8-5.7μ crass.; cellulae 5.7-7.6 μ longae in regione basali, 7.6-46.8 μ longae in regione capilli; heterocysta singula, sphaerica, 11.5 μ diam.; sporae longae et cylindricae, nonnumquam tenuiter curvatae, 11.5-15.3 μ latae, 46-84.4 μ longae, episporio levi et hyalino. Typus lectus mense aprili 1960 et positus in Hoshiarpur herbario collegii Gubernii sub numero *Vasishta* 9.

Thallus small, 1-2.5 mm. in diameter, yellowish brown ; trichomes constricted ending in a long hair ; sheath at the base thick and brown ; heterocysts single, spherical ; spores long and cylindrical, sometimes slightly bent, epispore smooth and hyaline.

Lat. trichome at base=7.6-11.5 μ; lat. trichome at apex=3.8-5.7 μ ; long. cell=5.7-7.6 μ, long. cell in the region of the hair=7.6-46.8 μ; diameter heterocyst=11.5 μ ; lat. spore=11.5-15.3 μ ; long. spore=46-84.4 μ ; crass. vag. at base=3.8-5.7 μ.

Habitat : Planktonic in a roadside pond, Phagwara road, Hoshiarpur. Collected on April 21, 1960.

The type is deposited in Government College, Hoshiarpur Herbarium under reference number *Vasishta* 9.

This form resembles the variety in the dimensions of the cells and breadth of spores ; but differs in possessing (*a*) smaller dimensions of the thallus, (*b*) heterocysts always spherical and not at all ellipsoidal, and (*c*) spores cylindrical and longer.

The length of the spores brings this form slightly closer to the variety *longispora* Rao, C. S. (1939, 146).

Order STIGONEMATALES Geitler

Family MASTIGOCLADACEAE Geitler

MASTIGOCLADUS Cohn

48. **Mastigocladus laminosus** Cohn in Abh. Schles. Ges. Vaterl. Cultur 2 : 39, 1863 ; Geitler 558, figs. 350-352, 1932 ; Desikachary 581, pl. 127, figs. 1-9, 1959. *Haplosiphon laminosus* Hansgirg in Bot. Centralbl. 22 : 48, 1885. *Anabaena bullosa* Kütz. Phyc. Gen. 212, 1843.

Lat. main filament=7.6-9.2 μ; lat. main trichome=5.7-7.6 μ; long. cell of the main trichome=3.8-11.3 μ; lat. trichome in branches=3.8-6.6 μ; long. cell of the branches=5.7-19.2 μ; lat. hair = 1.9-3.8 μ; lat. heterocyst=3.8-6.6 μ; long. heterocyst=7.6-19.2 μ.

Habitat: Forming blue-green or olive-green, membranous thallus on the moist soil by the side of a *cho* near Model Town, Hoshiarpur.

ACKNOWLEDGEMENTS

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The Giant Stick Insect, *Eurycnema goliath* (Gray)

BY

H. J. KITCHENER, F.Z.S.

(*With six plates*)

Several years ago, prior to my departure on long leave, two large long-legged green-winged insects were brought to me. There was nothing I could do then about keeping them, so very reluctantly I had to refuse the gift. As the result of another gift early this year (1960) I have been able to observe and record the life-history of the insect, *Eurycnema goliath* (Gray), the Giant Stick Insect of Malaya and adjacent territories.

The gift consisted of some thirty eggs reported to have been laid by a large green-winged insect caught while clearing and burning jungle. The eggs were oval and slightly flattened, 5 mm. in length and 4 mm. in diameter; grey-brown in colour and very hard shelled. At one extremity was a small circular brown disc, superimposed on the centre of which was a small light brown sphere 1 mm. in diameter. This small sphere appears to have no function or practical use as it lacks contents and is often knocked off or damaged before the egg hatches. Eggs take some eight months to hatch. This period can be reduced somewhat by exposure to indirect sun heat.

The eggs were kept in a muslin-covered jar on a bed of coarse sand and were exposed to a certain amount of heat from indirect sunlight. Occasionally they were placed in a small wire sieve and given a thorough washing and soaking for a few minutes and returned to the jar.

Hatching is accomplished by the emerging nymph pushing out the brown disc at the extremity of the egg. This is actually a lid unsealed when the nymph is ready to emerge. The egg is lined with a thick white parchment-like membrane which is ruptured and left in a dry and crumpled condition in the egg after the nymph has left it.

The newly-hatched nymph is 2 cm. long, very thin in body, and with long slender legs. The overall colour is dark brown—almost black. Forty-eight hours after hatching the nymph commences to feed.

Mine were all raised on guava (*Psidium*) leaves which they readily accepted.

At the end of 11 days, by which time the body length is 3.20 cm., the first moult or ecdysis takes place; and when this is complete the body length has increased to 4.15 cm.

When the moult is imminent the nymph hangs upside-down from a leaf; in the case of larger nymphs twigs with an inclination towards the horizontal are selected. The nymph also makes sure that there is a clear free space immediately below. The legs are spread and firmly hooked to leaves and twigs; the abdomen droops earthwards. Some forty-eight hours prior to the moult it ceases to feed and remains immobile; shortly before the moult it moves about selecting the site.

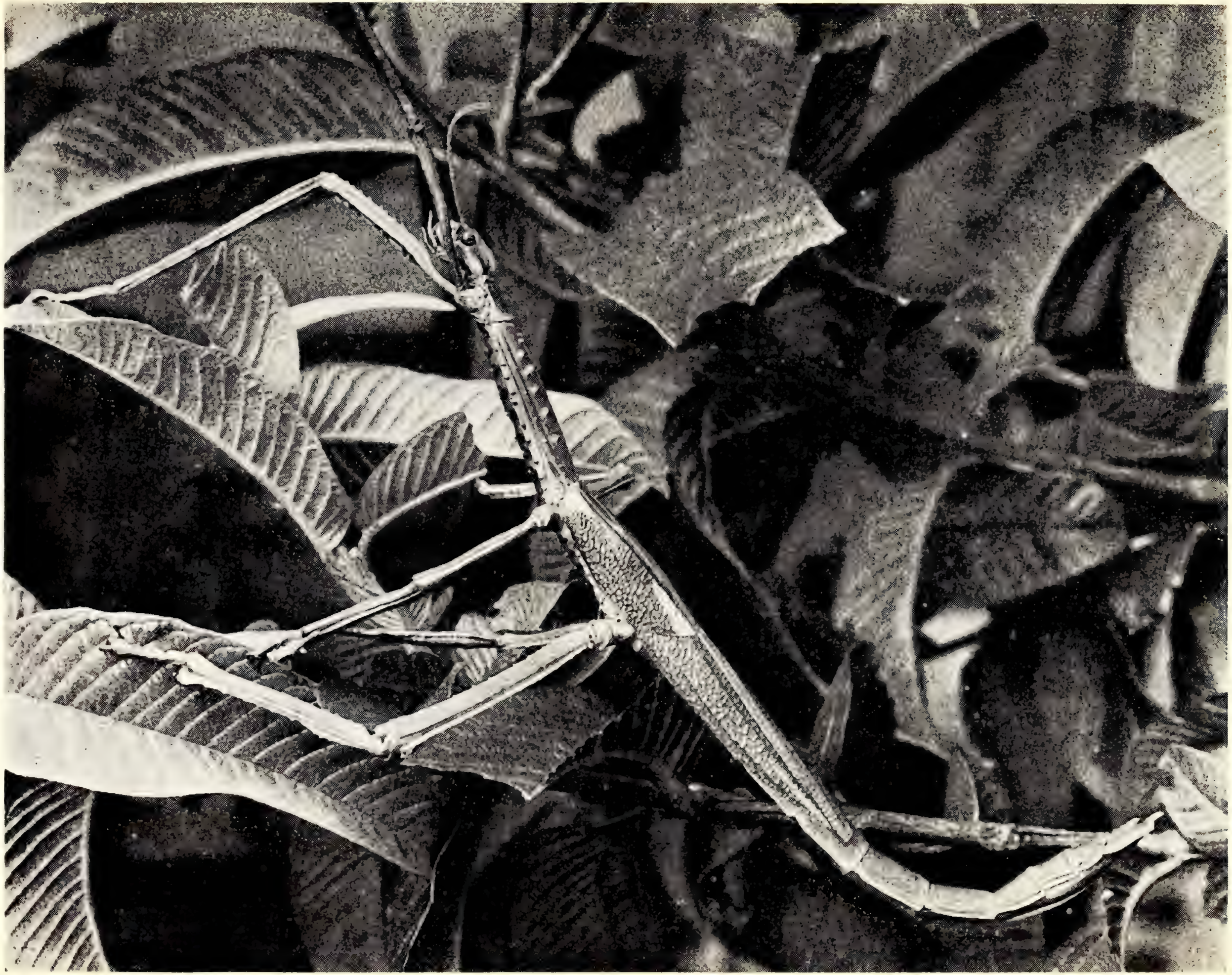
The first indication of the moult is the up-and-down movement of the drooping abdomen and a see-saw motion of the head and thorax. The old skin splits down the centre of the upper thorax to just below the nymph wings. The head begins to bend inwards towards the underside of the thorax as the head is withdrawn from the slough. The head, thorax, legs, and abdomen are drawn out of the old skin by the pull exerted by the thorax straining, pulling, and heaving on the long legs, slowly extracted from the old skin firmly anchored to the leaves and twigs.

The chitin of the newly exposed skin is very soft and pliable; as the legs are withdrawn they are subjected to the most impossible angles, angles which would immediately snap them under any other circumstances.

As the moult progresses the tips of the legs can be seen gradually moving down and out of the old transparent skin under the pull of the straining thorax. Eventually all six legs are free. The head resumes its normal position. The insect is now held head downwards by the retention inside the old skin of the last two segments of the abdomen and the wing-like appendages at its tip. These appendages must be provided for this special purpose as they have no other function. In this precarious position the insect is held while the skin hardens. The legs and antennae are gently flexed and stretched. The now adult insect has increased considerably in size during the moult, a change which assists it in getting rid of its old skin.

Except for the period between hatching and the first moult little growth occurs between moults. Practically all increases in body length and bulk take place at the moults.

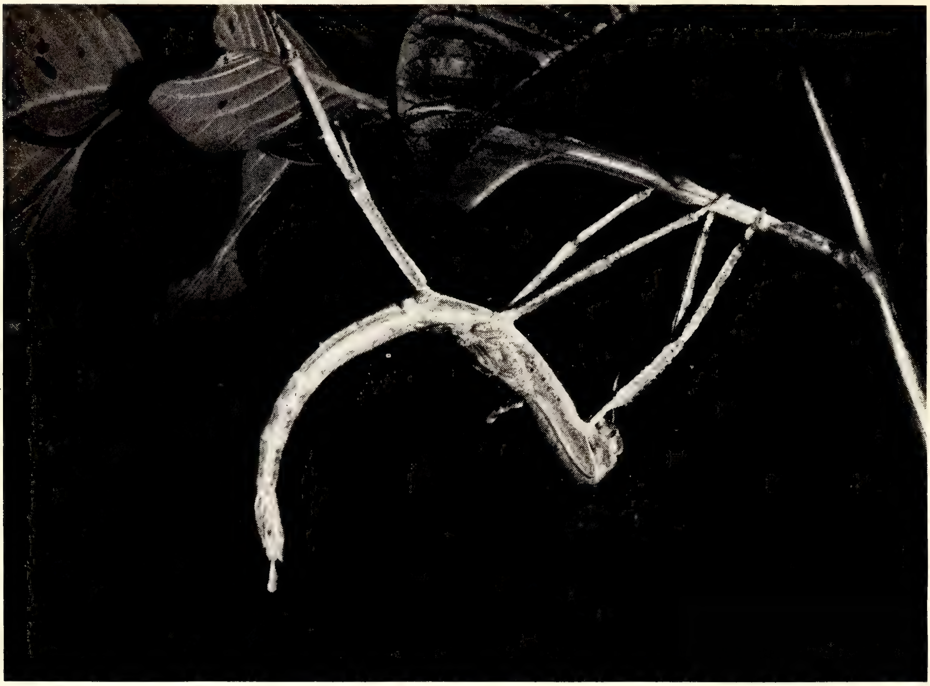
After a period of half-an-hour to an hour suspended in this



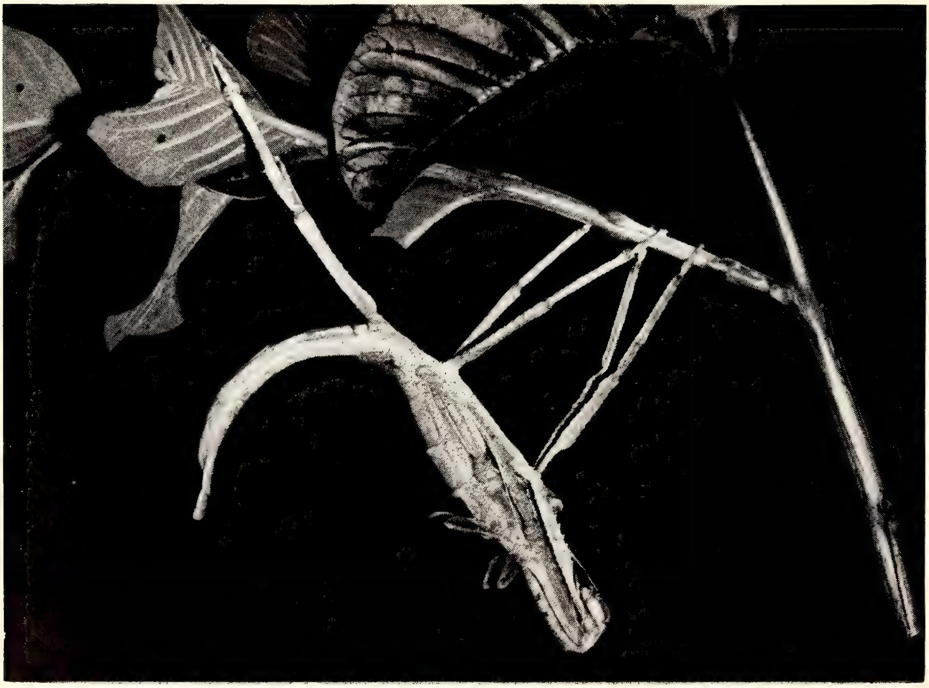
Adult Eurycnema goliath, the Giant Stick Insect

Photo : H. J. Kitchener

Eurycnema goliath, the Giant Stick Insect : The Moult



The nymph in position for ecdysis. The old skin has split along the thorax and the body is working out.



Body coming out of the old skin

Photos : H. J. Kitchener

peculiar manner the abdomen is bent inwards and upwards so that the legs are able to grasp the empty skin and leaves. The position of the body is now reversed, head uppermost and body hanging vertically. After a further period, up to several hours, the nymph commences to eat the empty cast skin, consuming as much as it can reach. Having consumed the shed skin it takes up a position on the food-plant where it remains immobile for a further twenty-four hours before it resumes feeding on the food-plant.

The procedure of moulting is identical at all stages of the nymph's growth. With each moult the colour lightens to light brown, then pinkish brown, on to greyish brown, and finally to ash-grey. It is interesting to note that each individual nymph, after the first moult, has its own particular rate of growth. Nymphs hatched on the same day within an hour or so of each other will undergo the first and probably the second moult together, but after that the stages between the moults vary from 11 to 20 days in different insects. There is little indication that a moult is imminent other than the forty-eight hours' fast, complete immobility, and the taking up of the characteristic upside-down position. Details of the moults and the growth-rate of a typical nymph are given in the Table below.

TABLE

Moult No.	Length prior to moult	Length after moult	Days between moults	Growth at moult	
	cm.	cm.		cm.	
1	3·20	4·15	11	0·95	
2	4·15	6·65	11	2·50	≠
3	6·65	9·25	10	2·60	
4	9·25	12.15	13	2·90	
5	12·15	15·60	13	3·45	@
6	15·60	16·75	18	1·15	

≠ Embryo wings appear.
@ Embryo parts of 'egg-scattering' organ appear.

The final moult from nymph to the adult winged insect is no different from that of the earlier moults. The results, however, are very different. For several days prior to the final moult the nymph's ash-grey colour commences to show traces of pale green in mottled bars across the legs and down the sides and below the abdomen. Dark green bars appear on the underside of the thorax. The embryo wings turn green, thicken, and swell. The undercolour of green accentuates the thickness of the skin about to be shed. As the moment for the commencement of the moult approaches the underlying green intensifies and spreads to other parts. The characteristic upside-down position is assumed. Although nymphs in the early stages will undergo the moult at any time during the day or night the final moult always takes place at night, commencing in the early hours of the morning usually about 3.30 a.m. and completed by dawn.

This final moult takes several hours to complete. The moult in the younger nymphs takes anything up to an hour; with the fully-fed nymph it is a very lengthy business.

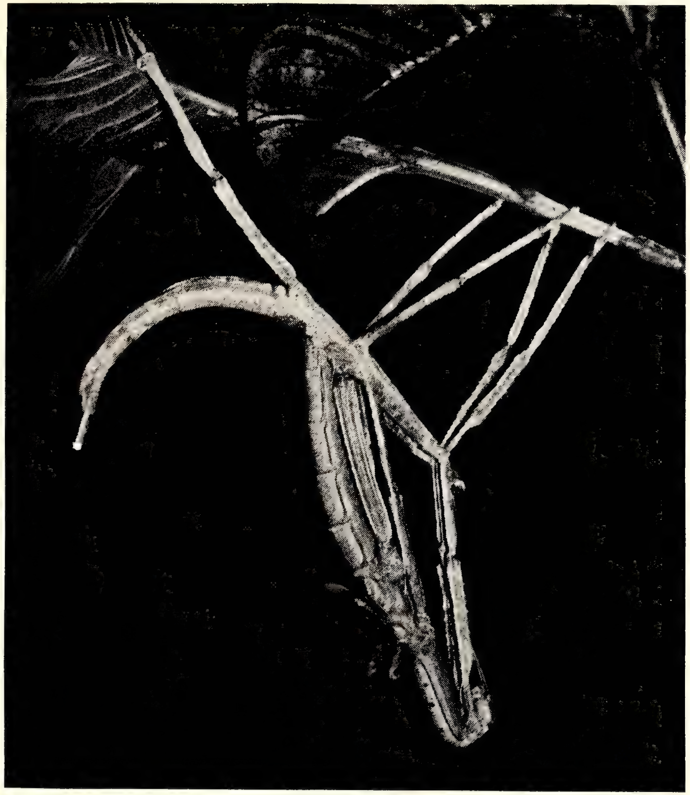
An hour or so after freeing itself from the old skin the now adult insect reverses its position and hangs vertically from the old skin. It is not until the vertical position is assumed that the embryonic wings commence to grow. They swell, thicken, and crinkle into green-and-red fleshy petals standing well away from the body. The colour is now green throughout. With the passing of time the wings lengthen and thin out until, after several hours, they reach maximum growth although still soft and flaccid. The vertical position is maintained without movement for several hours until the new skin and wings have hardened. Suddenly the insect shows signs of animation, and eargerly searches out and consumes its cast skin.

The 'egg-scatterer' at the extremity of the abdomen, parts of which made their appearance in embryonic form at the 5th moult, is now a very elaborate organ.

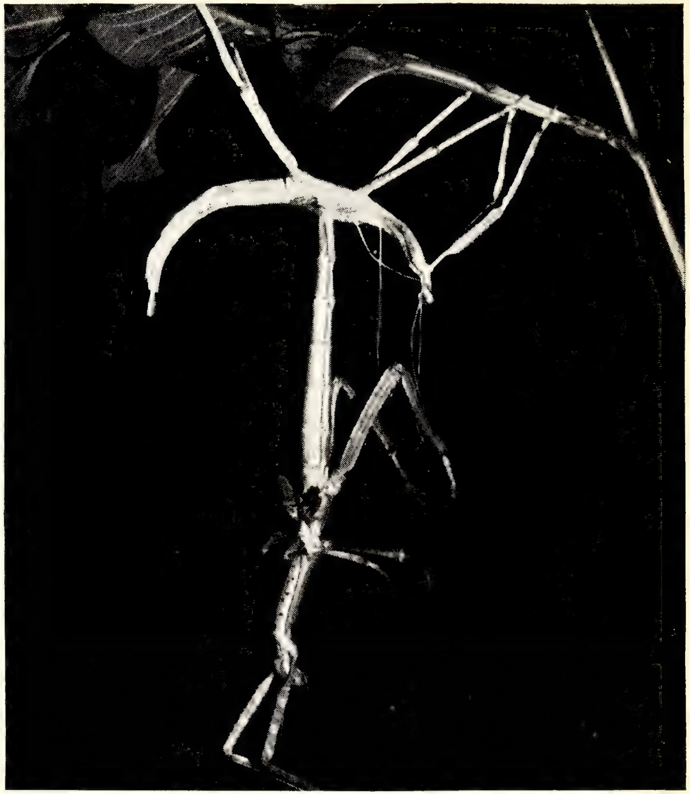
The colour darkens to a more solid apple-green. The underparts of the thorax are yellowish with mottled bands of dark green. The long legs are yellow with narrow mottled bands of pale green. The abdomen is pale green above and below with light creamy bands on the underside at the junctions of the segments. The short thick-based spines on the upper thorax are bluish green. On the short rounded forewings or tegmina are two small cream patches; the undersides are vermilion. The anterior portion of the hind wings resembles the tegmina in colour and texture; the posterior portion is transparent and pale azure blue. At the tips of the anterior green portions are short single narrow cream lines. The underside of the anterior part is also vermilion.

The new adult takes no food for another ten to twelve hours; from then on it eats ravenously, the abdomen rapidly increasing in size.

Eurycnema goliath, the Giant Stick Insect : The Moult (*continued*)

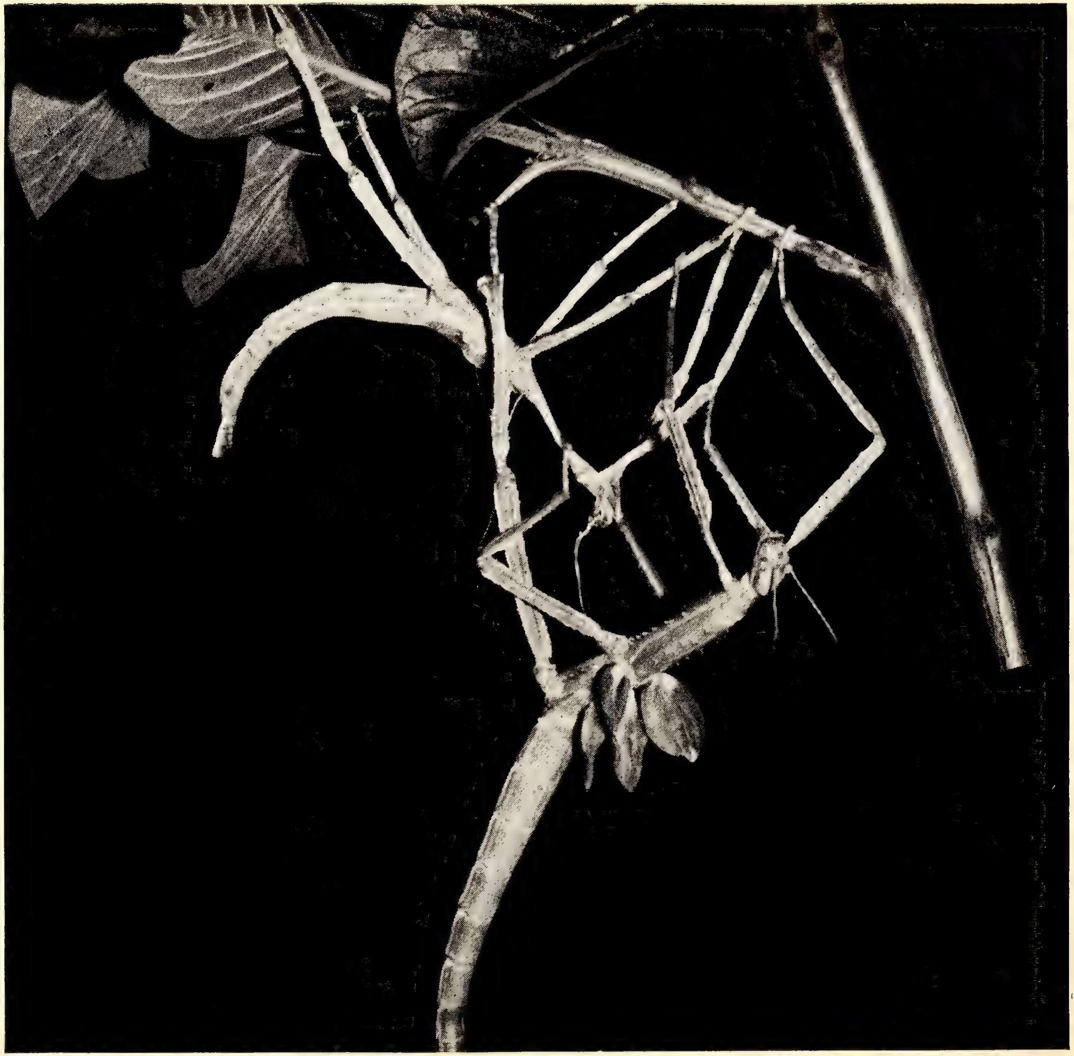


Body mostly emerged. Legs almost clear of old skin.



All legs clear. Tip of body firmly held in old skin. This position is maintained for an hour or more until skin and legs harden. Wings do not commence to grow until position is reversed.

Photos : H. J. Kitchener



Eurycnema goliath, the Giant Stick Insect

The insect, now fully emerged, has reversed its position and the wings start to grow. When the wings reach their full size and harden, the cast skin is eaten.

Photo : H. J. Kitchener

Egg-laying commences 17 days after the final moult. During this period the abdomen has grown to its maximum size, and is greatly distended with eggs. The body length has now increased from 17 cm. to 19 cm. In the early part of the egg-laying period eggs are laid at the rate of 3 to 4 per day. Towards the latter half numbers of small and very undersized eggs are laid.

This insect reproduces by parthenogenesis and does not require a male for the fertilisation of the eggs. It is highly improbable that males of this species are ever produced.

Egg-laying takes place at irregular intervals throughout the day and night. The first indication of the production of an egg is slight flexing of the long abdomen and minor gaping movements of the curved posterior scoop and its opposing member of the egg-scattering processes. After a short period, during which the movements of the abdomen increase, an egg passes from the body into the grip of the processes within the gape of the scoop and the upper portion. The egg is held in this position for some time. The anus is situated on the lower surface of the upper member of the egg-scatterer.

Two methods are used for the release of the egg. In one the scoop and the upper portion gape widely and the egg is released from the inner retaining processes to fall directly to the ground. In the other the extremity of the abdomen is given a sudden sharp upward flip which propels the egg some considerable distance, the curved scoop or shute giving the egg the necessary trajectory for distance. Eggs are often dropped or thrown while the insect is busily feeding.

The number of eggs laid by these insects is well in excess of 500—by actual count an average of 505 over a period of 153 days, making an average of 3.3 eggs per day. This average does not take into account eggs which may have been projected too far to be recoverable and others lost from various causes. The figure of 505 eggs means that one insect is capable of producing 125,000,000 progeny in a period of less than five years in the third generation, assuming that all reach egg-laying maturity and produce their full capacity of eggs. Eight months from laying of egg to hatching; three months in the nymph stage and six months as an adult egg-layer.

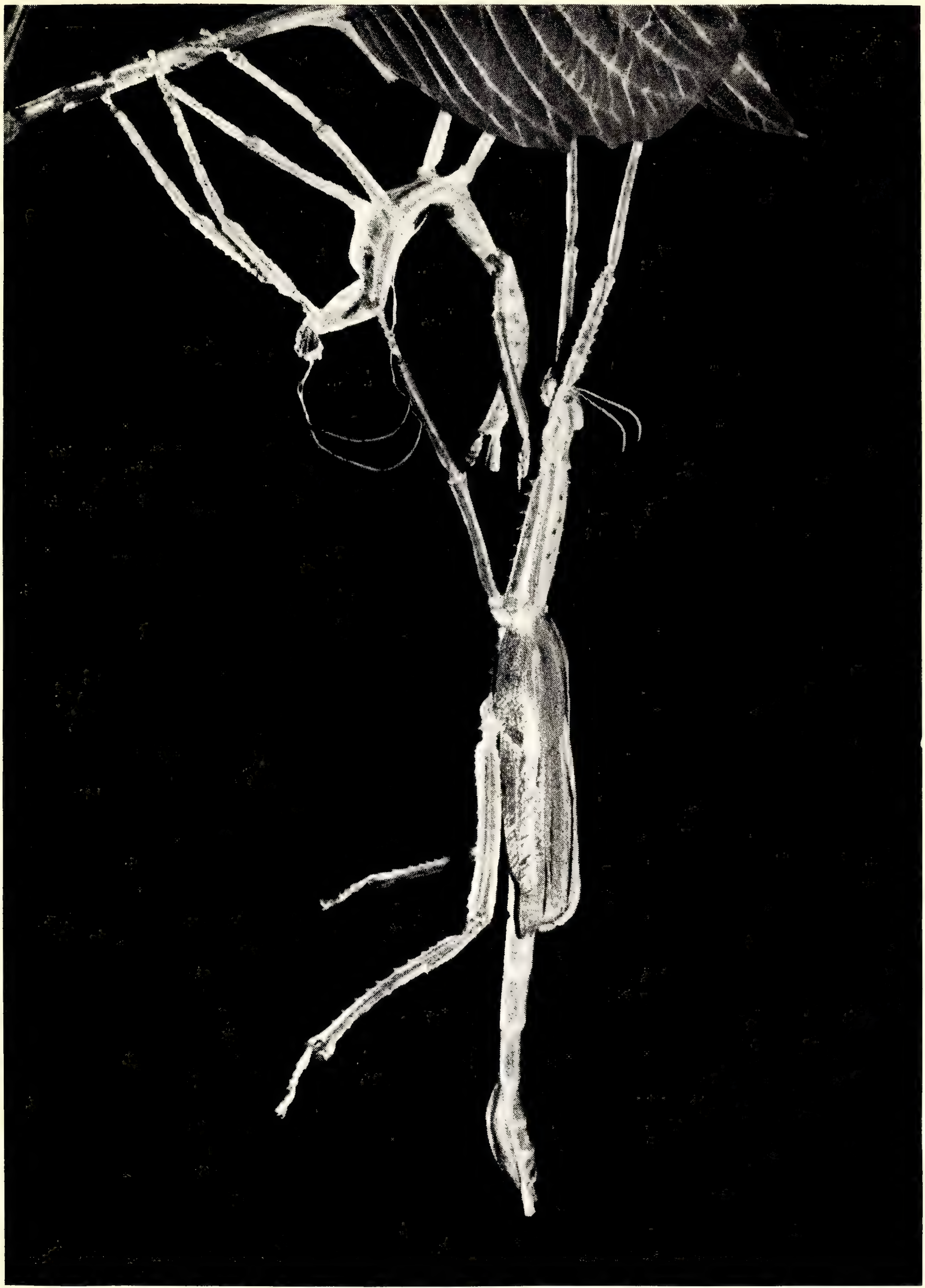
It is obvious from these figures that the infant mortality-rate is extremely high and that only a very small percentage of these insects reach egg-laying maturity. The very small newly-hatched nymph, emerging from the egg amongst the herbage and debris of the jungle floor, must have an amazing number of hazards and dangers to contend with before reaching the comparative security of the foliage of its lofty food-plant, which it must find and ascend. The eggs, also, lying unprotected and exposed on the jungle floor, must be consumed in large numbers by ground-living birds, ants, and others. Heavy rain will also wash away and cover many with soil and debris. Having reached their food-plant they are still by no means invulnerable and must often fall victims to birds, geckos, lizards, and ants. The ash-grey bleached dead-twig appearance of the growing nymph and the leaf-green of the adult insect camouflage them to a certain extent, but there must be numbers of keen-eyed insect hunters which see through this and make meals of many of them. The mortality-rate amongst the nymphs at the later stages of growth is probably not so high. It is reasonable to assume that very few, if any, of the adult insects survive long enough to be able to lay anything approaching the maximum output of eggs under natural conditions in the open jungle. Raised under artificial conditions all hazards are eliminated, except house geckos which will attack and eat the young nymphs in the first and second stages of moult.

When ready for a meal both nymph and adult sway the body gently from side to side a number of times, the mouth-parts agitating rapidly. Moving over the foliage the edge of a leaf is soon found and taken in the guiding palps which direct it to the mandibles within. The agitation of the mouth-parts ceases abruptly at the first bite. Under artificial raising shaking the food-plant or its agitation by breeze or wind immediately starts these insects swaying and feeding.

They are quite harmless and take very kindly to gentle handling when being transferred to a fresh food-plant. The nymph in the younger stages is inclined to panic somewhat when handled, but as they increase in size and age become accustomed to handling and seem to anticipate the provision of fresh food-plant.

The inner edges of the tibias of the hindmost or third pair of legs are armed with a series of sharp spines. Should one's finger touch the body near these legs a sudden flexing of the legs nips the offending finger between the spines of the tibia and the femur. No wounds are inflicted but the sudden flexing of the leg and the prick of the spines on the finger provides a considerable surprise and is a very effective deterrent to further molesting. This defensive action may well prove very effective against geckos, lizards, and other small creatures. The tibia spines are only present in a very reduced form in the nymph, the spines developing at the final moult. The nymph therefore has only its protective coloration to depend upon to evade detection and sudden death.

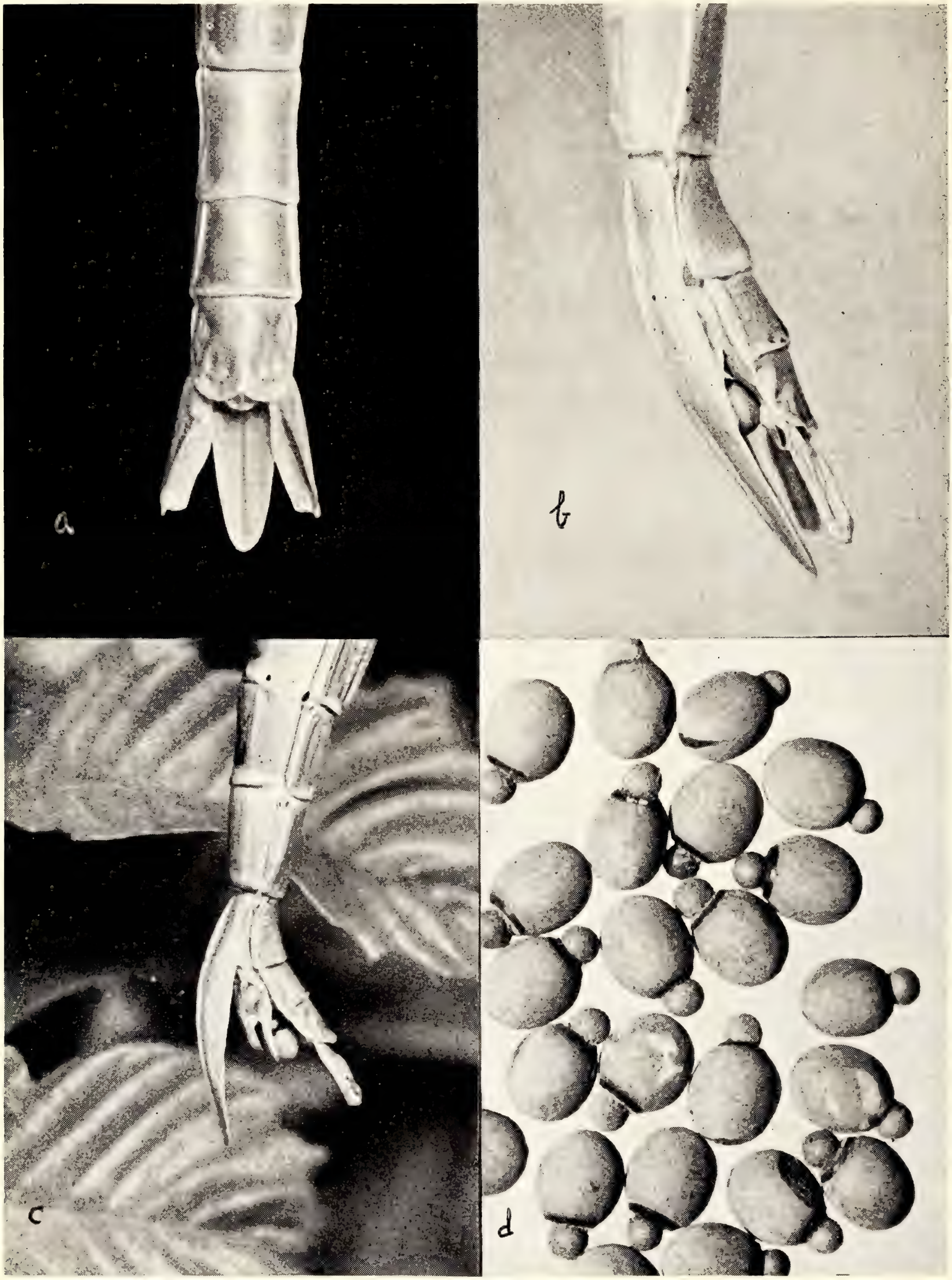
Eurycnema goliath, the Giant Stick Insect



Wings nearly full grown. Body very thin but fills out with eggs after 17 days of feeding at which time egg-laying commences.

Photo : H. J. Kitchener

Eurycnema goliath, the Giant Stick Insect



a. The tip of the abdomen (from the top) showing wing-like appendages, *c.* × 1·3; b. The egg emerging and still held by the claspers; c. The egg about to be discharged; d. The eggs, *c.* × 2·2

Photos : H. J. Kitchener

These insects do not like the direct rays of the sun and seek shelter amongst the foliage when exposed. They take to the wing during the hours of darkness.

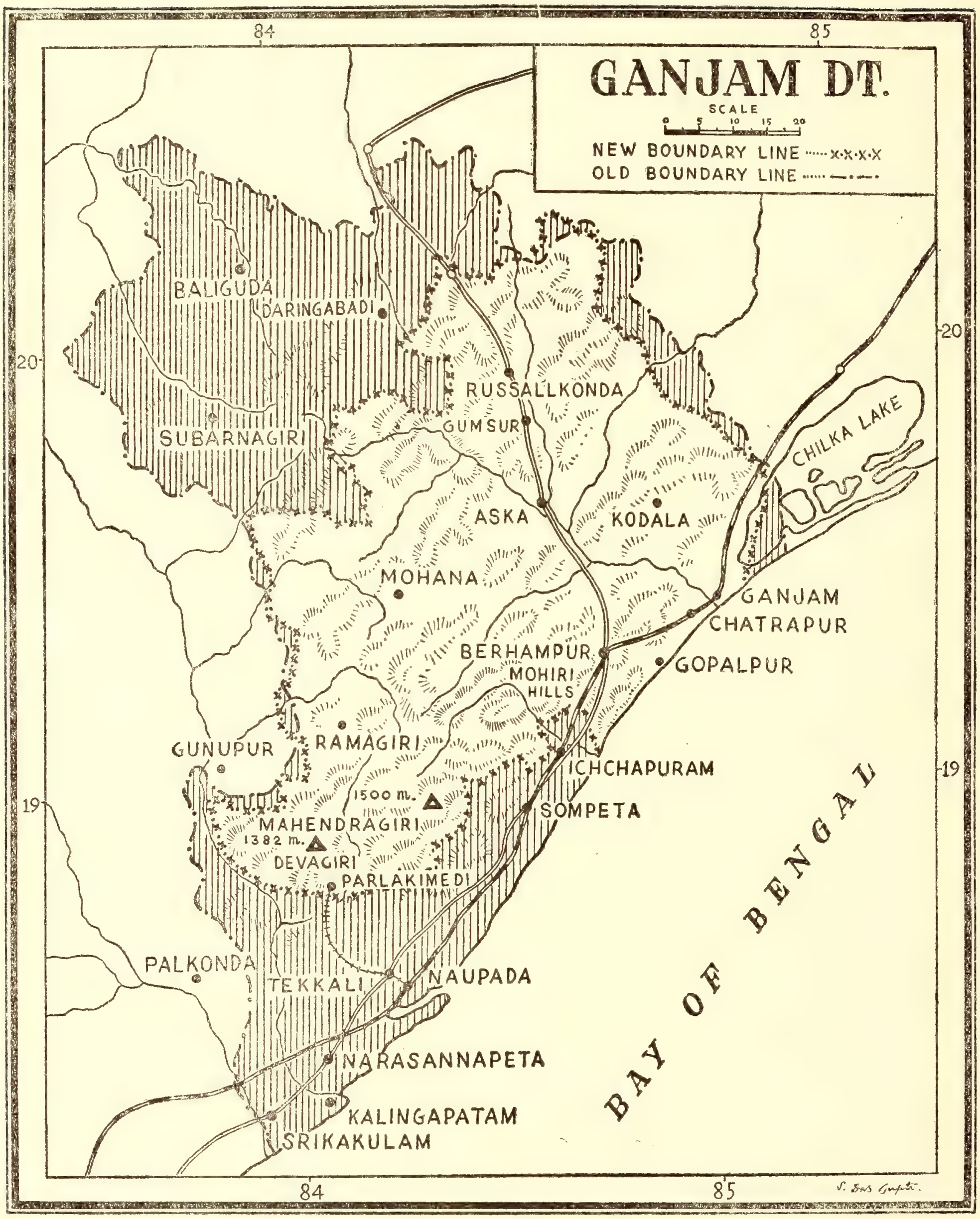
A rather singular feature in the life of the stick insect nymph is its ability to regenerate limbs and antennae which have been lost or damaged. Limbs part from the body without any particular difficulty, sense of discomfort or loss, as though such occurrences are of no moment—comparable to the so-readily-abandoned tail of the gecko, and with the same regenerative capacity. Limbs lost in the early nymph stages regenerate into useful functional members but fail to reach the size of their counterparts at the final moult. Mutilations occurring near the final moult are carried through to the adult insect as deformities which are quite functionless and often merely grotesque appendages. On one occasion a nymph emerged from the egg but, owing to some misfortune, one of the third pair of legs was unable to free itself from the parchment-like membrane lining the egg. This resulted in severe malformation of the tibia and tarsus with the membrane twisted up in the deformity and still attached to the leg. I was fortunate enough to observe the first moult of this small nymph and was particularly interested to see how it would deal with this unfortunate state of affairs. The problem was solved speedily and effectively. As the tarsus and tibia would not withdraw from the skin of the leg, the malformation offering too much resistance, several strong heaves of the thorax broke away the leg at the body, leaving it in the shed skin. The moult proceeded without further incident, the stump healing over with a brown chitinous skin. This leg has regenerated into a perfect limb which is slightly smaller and shorter than its counterpart. The tarsus and tibia are equal in length to those of the opposing limb; the femur is, however, appreciably shorter and finer. The loss of a limb or limbs retards the nymph's growth slightly, this shortcoming being made up at the final moult.

The Malays refer to the nymph form of this insect as *chengkadak* and the mature green adult as *belah-belong,* crediting it with possessing a very loud shrieking voice of considerable volume during the hours of darkness. I have heard loud prolonged cries in the jungle at night on numerous occasions, credited by my men to the *belah-belong.* Some were really blood-curdling in cadence and volume but I have never been able to locate the culprit, in spite of extensive search with powerful electric torches. If the insect is really responsible, the 'voice' is most definitely produced while on the wing.

Careful examination of the mature insect discloses no apparatus which could be used as a sound-producer, although the wings may well play some, if not all, part in the production of these noises. The fact that the 'voice' is heard at night and while the producer is airborne gives credence to the belief of the superstitious amongst the Malays, that these are the cries of passing spirits, jinns, and other denizens of the underworld and carry misfortune and sickness in their wake. It is possible that confusion and uncertainty exist in the identification of this particular insect as the source of these night cries. The creature responsible may well belong to an entirely different species, a large cicada, for example. An insect of some kind is responsible, as they have passed over my camp at night on several occasions. The volume of the sound when directly overhead is quite deafening in the dead silence of the jungle night.

This stick insect is well known to the Chinese of this country who consider its dung a source of a very useful medicine. The eggs are also used but not to the same extent. The centimetre-long bat-like dung pellets are steeped in water, and the resulting dark-brown tea-like liquid is taken internally as a cure for digestive troubles, heartburn, dyspepsia, looseness of the bowels, etc. I have no idea what the active ingredient or agent may be in this concoction; I suspect tannic acid. As a cure or palliative for such troubles it may well possess some pharmaceutical merit.

Wetted dung pellets of the giant stick insect and also those of the atlas moth larva, both fed on guava (*Psidium*) leaves, cause a dark-brown persistent stain on wood, concrete, and cloth. A clean polished steel knife blade used for cutting guava twigs very quickly turns black, similar in effect to the cutting of oak twigs and bark, which have a high tannic acid content. This somewhat rough-and-ready test suggests the presence of tannic acid in the sap of the guava leaves and consequently in the dung.


GANJAM DT.
SCALE
0 5 10 15 20
NEW BOUNDARY LINE ······x·x·x·x
OLD BOUNDARY LINE ······ —·—
84
85
20
19
BALIGUDA
DARINGABADI
SUBARNAGIRI
RUSSALLKONDA
GUMSUR
ASKA
KODALA
CHILKA LAKE
MOHANA
GANJAM
CHATRAPUR
BERHAMPUR
GOPALPUR
MOHIRI HILLS
RAMAGIRI
GUNUPUR
ICHCHAPURAM
1500 m.
SOMPETA
MAHENDRAGIRI
1382 m.
DEVAGIRI
PARLAKIMEDI
BAY OF BENGAL
PALKONDA
TEKKALI
NAUPADA
NARASANNAPETA
KALINGAPATAM
SRIKAKULAM
S. Das Gupta

Map of Ganjam District, showing the pre-1935 and post-1935 boundary lines.

The Flora of Parlakimedi and its immediate Neighbourhood

PART I

BY

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(*With a map*)

Parlakimedi (18° 47′ N., 84° 5′ E.) in the Ganjam District lies at the southern-most part of Orissa. It is situated in the midst of moderately high hills which are continuations of the Eastern Ghats. Devagiri (1382 m.), the second highest peak in the Ganjam District and next only to Mahendragiri (1500 m.), is just 12.9 km. from Parlakimedi and north of it. The Bay of Bengal coast is within 41 km. east of Parlakimedi. It enjoys the effects of both the NE. and SW. monsoons and the annual rainfall is also fairly appreciable, the average being about 115 cm. The topography, climate, and natural surroundings have consequently endowed the place with varied types of vegetation and in favourable localities relatively thick forests also occur.

However, no account of the flora of Parlakimedi appears to have been published so far. Probably this was due to the restrictions imposed in the former days on entry into this and other similar territories falling within the administration of the then native rulers and zamindars in the various States and Provinces in India under the British regime. As a result, the flora of the greater portion of Ganjam District was meagrely worked out. The very few localities botanised in the district were outside these restricted areas and the work was done mainly by officers of the forest departments.

Even here, areas in north Ganjam appear to have received the main attention. Thus Gamble (1884 & 1884-85) gave an account of the forests of the Northern Forest Circle of the old Madras Presidency and the vegetation of the Northern Circars. In these accounts he dealt with the species found in Gumsur, Kurcholy Forests, Mahendragiri, Palkonda (which has gone out of Orissa with the formation of Orissa State in 1935), Surada, Berhampur, Mohri Hills, Maliah Hills, Russelkonda, Aska, and some of the Agency tracts. Fischer (1904) published an account of the flora of north Ganjam District, confining his species to those found in Berhampur and Gumsur taluks. In this he listed about 529 species of flowering plants. Mukherjee (1935), however, described the plants of the Mahendragiri in which he has listed about 60 species under 28 families.

Stray references to the species from Parlakimedi are to be found in FLORA OF NORTHERN CIRCARS by Gamble (1884-85), PRICKLY PEARS OF INDIA by Burkill (1913), and in VERNACULAR NAMES OF TREES, SHRUBS AND CLIMBERS OF MADRAS PRESIDENCY by Lushington (1915). But for the five species *Butea superba* Roxb., *Opuntia vulgaris* Mill., *Opuntia dillenii* Haw., *Ficus benjamina* Linn., and *Reinwardtia trigyna* Planch. mentioned in the above works, practically nothing is known of the flora of Parlakimedi in south Ganjam, while the flora of north Ganjam is comparatively fairly well known. Obviously with intent to complete the knowledge of the flora of the entire district, some attempts were made to explore the Parlakimedi area by some of the early botanists. Burkill paid two consecutive visits to Parlakimedi, one in December 1902 and another in September-October 1903. During these visits he made very good collections of plants of the area, either by himself or in collaboration with a few others, the principal among whom were Lt.-Col. D. St. J. Grant, Edmund Candler, Rev. H. Y. Corey, and G. Ramamurthy. The valuable collections so made were deposited in the Indian Museum in the herbarium of the Industrial Section, of which institution Burkill was in charge as Reporter on Economic Products to the Government of India. Obviously the intention was that Burkill should study the collections in greater detail and publish an account of the Flora of Parlakimedi. Unfortunately, that publication did not materialise—the constitutional changes that took place in the administrative set-up of the Industrial Section and the break-down in Burkill's health appear to have interfered with the progress of the work on the Flora of Parlakimedi.

The present account is based on a detailed study of the valuable collections made by Burkill and his collaborators during the years 1902-03, now in the Industrial Section, Indian Museum, and on field observations made independently by the junior author during the period from 1946 to 1955.

VEGETATIONAL ASPECT

The following places have been taken into account in presenting the vegetational aspect of Parlakimedi : Parlakimedi proper, Pathapatnam, Gumma Gedda, Nutulova Konda, Boya Hill, Devagiri, and the banks along the river Mahendratanaya and other irrigation channels. The vegetation in and about the two beautiful large tanks, Ramasagaram and Sitasagaram, is also briefly considered. Altitudinally, the vegetation is dealt with to beyond 1220 m. and up to the very top of Devagiri. The species which are cultivated or planted here and there are included in the present account to give a more complete picture.

It is interesting to note that Parlakimedi and its immediate neighbourhood mark the southernmost limit for Sāl (*Shorea robusta* Gaertn.). The general aspect of the vegetation bears great similarity to that of the Deccan, but with this difference that in Parlakimedi and its neighbourhood it is interspersed with Sāl.

The vegetation of Parlakimedi may broadly be classified under the following few distinct types :

1. Vegetation of the sandy areas,
2. Vegetation of the low hill jungles,
3. Vegetation of dry broken jungles,
4. Vegetation of dry rocky hill slopes,
5. Vegetation of the valleys,
6. Vegetation at different altitudes,
7. Vegetation at river sides and tank vicinities,
8. Cultivated species.

1. VEGETATION OF THE SANDY AREAS

A great part of the area, except perhaps the cultivated fields and the jungles and hills in and about Parlakimedi, is dry and sandy. Typical sandy tracts are met with in the north and north-east about Boya Hill, in the north and north-west beyond Ranipeta, in the west near about Nutulova Konda and beyond, and in the south towards Pathapatnam. In wide sandy stretches, *Solanum xanthocarpum, Leucas cephalotes, Evolvulus alsinoides* form the characteristic species. On sandy roads and waysides, *Celosia argentea, Pedalium murex, Carissa spinarum, Orthosiphon pallidus* are common. *Scoparia dulcis* is found on sandy bunds, and *Centranthera humifera* is met with at edges of ragi, (*Eleusine coracana*) fields with *Celosia argentea. Tridax procumbens, Cassia* sp., and *Tephrosia purpurea* constitute the dominant forms in such sandy areas. *Tephrosia purpurea* was found always dominant over *Cassia occidentalis*. Among the other characteristic species of the area, mention may be made of *Indigofera linifolia* and *Oldenlandia herbacea.*

Where the sandy tract is wet, as in the vicinity of Gumma Gedda and irrigation-channel outlets of Ramasagaram and Sitasagaram and in other low-lying areas, grasses and sedges are dominant. Among the characteristic forms to be mentioned are *Cyperus* sp., *Chrysopogon aciculatus* (=*Andropogon aciculatus*), and *Cynodon dactylon.* A few other species also occur on sandy substrata in hill jungles and valleys, and are given below in their respective places.

2. Vegetation of the Low Hill Jungles

Ailanthus excelsa and *Crotalaria albida* are the common species in certain areas at the foot of the hills, the latter sometimes running wild as a weed among millet crops. On barren ground in such hill jungles, *Oldenlandia nudicaulis* is plentiful in some places. In jungles, where the substratum is more sandy, *Hugonia mystax*, *Murraya paniculata*, and *Maba buxifolia* are the characteristic species. Among the various other species of low hill jungles are *Cissampelos pareira*, *Flacourtia indica*, *Pavonia odorata*, *Aspidopterys roxburghiana*, *Oldenlandia nitida*, *Tarenna asiatica*, *Morinda tinctoria*, *Holarrhena antidysenterica*, *Cassia* sp., *Cryptolepis grandiflora*, *Ceropegia tuberosa*, *Erycibe paniculata*, *Argyrea choisyana*, *Leucas mollissima*, *Bridelia retusa*, and others. *Justicia glauca* and *Oldenlandia nudicaulis* are also plentiful in such jungles. *Knoxia corymbosa* occurs, however, in low hill jungles which are very thin. *Alstonia neriifolia* is a species at the summit of rocky jungles.

At comparatively higher elevations, on some of these hills, many shrubs flourish and many herbs intrude. In favourable spots bamboos constitute major formations. Among such bamboo formations, *Thespesia lampas* grows in some localities. In dense and shady situations and by the sides of streams, *Barleria strigosa* is common. On steep hills, *Litsea glutinosa* is to be seen. *Cissus vitiginea* and *Desmodium gangeticum* are the more common climbers and undershrubs in these jungles, the former hanging from large shrubs or trees. *Bidens pilosa* is characteristic at the top of these hills. Among the other species of hill jungles are *Cissampelos pareira*, *Pavonia odorata*, *Aegle marmelos*, *Ailanthus excelsa*, and *Butea monosperma*.

3. Vegetation of the Dry Broken Jungles

Here and there the jungles are interrupted and appear as open and broken jungles with huge boulders and barren tracts intervening. Among the characteristic species in this type of jungle are *Hybanthus enneaspermus*, *Antidesma diandrum*, and *Adina cordifolia*. Among rocks in such areas, and fringing these jungles, are *Pseudarthria viscida* and *Derris scandens*. *Alstonia neriifolia* is found at lower levels, while *Sida veronicaefolia* is met with at higher levels. *Mimosa rubicaulis* and *Knoxia corymbosa* are very common in these jungles.

4. Vegetation of the Rocky Hill Slopes

The following are characteristic of hill slopes : *Helicteres isora*, *Trichosanthes cucumerina*, *Blepharis maderaspatensis*. Where it is stony and dry, *Caralluma adscendens*, *Blepharis molluginifolia*, and *Phyllanthus* *maderaspatensis* are very common. In such and similar dry situations, *Flacourtia indica, Hibiscus micranthus,* and *Indigofera glandulosa* are also found.

Rocky and sandy hill slopes are common on the Boya Hill, Nutulova Konda, and the lower parts of Devagiri. *Holarrhena antidysenterica* is the dominant species in some places with *Azadirachta indica.* Among the other species are *Justicia betonica* and *Allophyllus serratus.*

5. VEGETATION OF THE VALLEYS

At the edges of forest in valleys are such species as *Alysicarpus vaginalis* and *Atylosia scarabaeoides,* the latter climbing on shrubs and trees. In the interior of the jungle in valleys are *Shorea robusta, Aegle marmelos, Madhuca indica,* and *Diospyros tomentosa. Butea monosperma* is found in certain places widely spread in the jungle parts of the valleys and *Argyrea choisyana* is seen climbing high on trees in Sāl forests. *Vitex pubescens, Rauwolfia canescens, Pergularia daemia, Datura metel, Bridelia tomentosa,* and *Cleistanthus collinus* are the other interesting species to be met with in the various parts of the valleys. At comparatively lower levels or at bottom of the valleys, *Merremia tridentata* and *Solanum melongena* are found growing in a wild state. Where the soil is sandy in the valleys, *Hibiscus micranthus* is seen under the shade of larger trees. In glades *Alysicarpus vaginalis* and *Borreria stricta* are not uncommon.

6. VEGETATION AT DIFFERENT ALTITUDES

Even though no clear demarcation can be made as to the altitudinal range of distribution of the various species in the hills, still some broad classification is possible. Thus, among the species found up to 30 m. altitude are *Dalbergia lanceolaria, Dalbergia paniculata, Dichrostachys cinerea, Woodfordia fruticosa, Operculina turpethum, Barleria prionitis, Aristolochia indica, Gmelina asiatica, Vitex trifolia, Antidesma ghaesembilla, Knoxia corymbosa, Hamiltonia suaveolens,* and *Hemigraphis elegans* in rather thin jungles at lower hill jungles of Devagiri. At 150 m. elevation, *Helicteres isora* is seen, but it extends up to 915 m. in Devagiri. Among the species at 305 m. level may be mentioned *Zizyphus incurva* at Devagiri with *Dendrophthoe falcata* on it, *Bauhinia acuminata, Careya arborea, Celosia argentea, Securinega virosa,* and *Tragia involucrata.* Among the species found at 610 m. may be mentioned *Zizyphus rugosa, Mangifera indica* in abundance, *Pterocarpus marsupium* (an extremely common species at this level), *Lagerstroemia parviflora, Madhuca indica, Emblica officinalis, Cleistanthus collinus,* and *Croton laevifolius.* Jowar, *Sorghum vulgare*, is cultivated here and there at this altitude on the hill slopes. *Phaseolus lunatus* is common in jowar crops.

Among the species at and beyond 915 m. are *Helicteres isora*, *Gymnosporia rothiana* (extending from 610 to 915 m.), *Adina cordifolia*, *Premna latifolia*, and *Martynia annua*. *Melasma avense* occurs as a weed in crops of millets grown at this elevation ; *Capsicum minimum* occurs as a cultivated crop at Devagiri, as in Savara hills. *Eriolaena hookeriana* is seen at the summit of Devagiri.

7. Vegetation at River Sides and Tank Vicinities

Along the river beds of Mahendratanaya, much cultivation is practised. Mango groves also abound along these tracts.

It is of interest to mention here that indigo cultivation was intense along the river sides in former days when the vegetable dye was holding the market. With the introduction of synthetic dyes, however, the cultivation of indigo had a set-back and was completely discarded ; in its place rice, maize, sweet potato, cabbages, and other vegetables are now cultivated.

On river bunds, the wild species more commonly seen are *Sida rhombifolia*, *Asteracantha longifolia*, *Grangea maderaspatana*, etc. In many places about Parlakimedi, *Aeschynomene indica* is abundant. A word may also be said about the vegetation in the tanks and on their bunds. In larger tanks, such as at Ramasagaram and Sitasagaram, *Nymphaea* and *Nelumbo* grow ; on the tank bunds *Polyalthia suberosa* and *Tylophora pauciflora* are met with. In some of the tanks *Utricularia flexuosa* lives as a hydrophyte.

8. Cultivated Species

Some species are often planted about the town of Parlakimedi, in gardens, on roadsides, along bunds of larger tanks, and at higher elevations in the hills. Some other economic species are also cultivated both in the lower terrain as well as at higher altitudes. Among the cultivated plants are *Guazuma tomentosa*, *Annona squamosa*, *Buettneria herbacea*, *Terminalia catappa*, *Punica granatum*, *Thevetia peruviana*, *Kigelia pinnata*, *Tabebuia pentaphylla*. Among the crops are jowar and other millets, rice, *Dolichos lablab*, *Dolichos biflorus*, *Capsicum minimum*. Millets and *Capsicum minimum* are sometimes cultivated on the hills at about 915 m. in some areas. In a few tracts *Buettneria herbacea* is planted and grown on rocky slopes about hill jungles. *Polyalthia suberosa* is common on the bunds of Ramasagaram, where *Tylophora pauciflora* is also seen as a wild species.

SYSTEMATIC ENUMERATION OF THE SPECIES

In the present paper, 286 species of flowering plants under 229 genera and 75 families have been enumerated from the Parlakimedi area. A study of the flora, as now presented, reveals at least 45 species as new records for Ganjam District, not being reported so far in earlier floras. Such new records are marked in the list with an asterisk. In the course of the present study we have noted a new host for *Dendrophthoe falcata* (Linn. f.) Ettingsh., viz. *Zizyphus incurva* Roxb., the only hitherto known host species of *Zizyphus* for this semi-parasite being *Z. glabrata* Heyne, *Z. jujuba* Lam., *Z. oenoplia* Mill. and *Z. xylopyrus* Willd. (Ravindra Nath and Narasimha Rao, 1959, pp. 204-212). Every attempt has been made to bring the nomenclature up-to-date with the literature at our disposal. In respect of a few species, however, considerable difficulties were encountered as to their correct nomenclature, as the same species are variously treated by different authors. Thus, *Saccharum arundinaceum* Retz. has been made a synonym of *Erianthus arundinaceus* (Retz.) Jesweit; THE WEALTH OF INDIA does not treat *Erianthus arundinaceus* (Retz.) Jesweit as a distinct species. Bor (1947) has also kept *Saccharum arundinaceum* Retz. as valid; in this enumeration, we have followed Bor and THE WEALTH OF INDIA.

Eragrostis tenella (Linn.) Beuv. ex Roem. & Schultz. and *Eragrostis unioloides* (Retz.) Nees have been treated as separate valid species by Bor (1947) and Majumdar (1956), while both the species have been combined into one by Raizada (1959). Here, too, we have followed Bor.

In the present enumeration, the Savara (S.) and Telugu (T.) names are given if known to the authors. The field numbers of Burkill and his collaborators are also given in their respective places.

NOTE. New records for Ganjam District are marked with an asterisk.

ANNONACEAE

Polyalthia suberosa Hk.f. & Th.

Parlakimedi: on the bund of Ramasagaram. *Burkill, Grant & Candler* 20538, Sept. 1903.

Annona squamosa Linn.

Parlakimedi: planted and grown here and there.

MENISPERMACEAE

Cissampelos pareira Linn.

Parlakimedi: in low hill jungles. *Burkill, Grant & Candler* 20435, Sept. 1903.

NYMPHAEACEAE

Nymphaea sp.

Parlakimedi: flowers white.

Nelumbo nucifera Gaertn.

Parlakimedi.

PAPAVERACEAE

Argemone mexicana Linn.

Parlakimedi.

CAPPARIDACEAE

Capparis sepiaria Linn.

Vern. Adein-jin (S.) ; Gulli chettu (T.)
Parlakimedi : at 304 m. *Corey & Ramamurthy* 20151, Sept. 1903.

VIOLACEAE

Hybanthus enneaspermus (Linn.) F. V. Muell. (*Ionidium suffruticosum* Ging.)

Parlakimedi : on top of a rock at edge of dry broken jungle. *Burkill* 20570, Sept. 1903.

FLACOURTIACEAE

Flacourtia indica (Burm. f.) Merr. (*Flacourtia sepiaria* Roxb. ; *Flacourtia ramountchi* L'Herit.)

Parlakimedi : on dry shrubby hillside. *Burkill* 20401, Sept. 1903 ; *Burkill, Grant & Candler* 20568, Sept. 1903.

DIPTEROCARPACEAE

Shorea robusta Gaertn.

Parlakimedi : common ; small trees in forests in valleys, attaining about 6 m. to 9 m. height. *Burkill, Grant & Candler* 20510, Sept. 1903 ; *Corey & Ramamurthy* 20123, 1903.

MALVACEAE

Sida veronicaefolia Lamk. (*Sida humilis* Willd.)

Parlakimedi : in jungles. *Burkill* 20480, Sept. 1903.

Sida acuta Burm. f. (*Sida carpinifolia* Linn. f.)

Parlakimedi.

Sida rhombifolia Linn.

Parlakimedi: in the neighbourhood of River Mahendratanaya. *Burkill* 18102, Dec. 1902.

Abutilon indicum G. Don

Parlakimedi.

Pavonia odorata Willd.

Parlakimedi : in lower hill jungles. *Burkill* 20459, Sept. 1903.

Hibiscus micranthus Linn. f.

Parlakimedi : on dry hill slopes and among rocks and bushes in broken jungle. *Burkill* 20562, Sept. 1903.

Hibiscus vitifolius Linn.

Parlakimedi : in valleys under shade of trees. *Burkill* 20549, Sept. 1903.

Hibiscus cannabinus Linn.

Parlakimedi : *Burkill* 21925, Sept. 1903.

Thespesia lampas (Cav.) Dalz. & Gibs.

Parlakimedi : among bamboos in hill jungles ; Devagiri. *Burkill* 17951, Dec. 1902 ; *idem* 20464, Sept. 1903.

Gossypium herbaceum Linn. (*Gossypium indicum* Lamk.)

Pathapatnam : *Burkill* 20492, Sept. 1903.

BOMBACACEAE

Salmalia malabarica (DC.) Schott. & Endl.

Parlakimedi.

STERCULIACEAE

Sterculia villosa Roxb.

Parlakimedi : *Corey* & *Ramamurthy* 20147, 1903.

Helicteres isora Linn.

Devagiri : 152-915 m. common on hillsides. *Burkill* 17957, Dec. 1902.

Parlakimedi : on rocky hillsides. *Burkill*, *Grant* & *Candler* 20418 ; *Burkill* 20439, Sept. 1903.

Pterospermum suberifolium Lamk.

Parlakimedi : Burkill 20565, Sept. 1903 ; *Corey* & *Ramamurthy* 20155, 1903.

Eriolaena hookeriana W. & A.

Parlakimedi : in hill jungles at the summit of hills. *Burkill* 20475, Sept. 1903.

Melochia corchorifolia Linn.

Parlakimedi : *Burkill* 20411, Sept. 1903.

Guazuma tomentosa Kunth

Parlakimedi : planted ; *Burkill* 20556, Sept. 1903.

Buettneria herbacea Roxb.

Parlakimedi : in rocky parts of hill jungles. *Burkill* 20457, Sept. 1903.

TILIACEAE

Grewia excelsa Vahl

Parlakimedi : in hill jungles ; *Burkill*, *Candler* & *Grant* 20455, Sept. 1903.

Grewia tiliaefolia Vahl

Parlakimedi : *Corey* & *Ramamurthy* 20119, 1903.

***Grewia abutifolia** Juss.

Parlakimedi : *Burkill*, *Candler* & *Grant* 20560, Sept. 1903.

***Corchorus aestuans** Linn. (non Forsk.) (*Corchorus acutangulus* Lamk.)

Parlakimedi : in hill jungles ; *Burkill* 20478, Sept. 1903.

LINACEAE

Reinwardtia trigyna Planch.

Vern. Labodatar (S.)
Parlakimedi (after Lushington 2 : 89).

Hugonia mystax Linn.

Parlakimedi : in hill jungles on sandy substrata ; *Burkill* 20424, Sept. 1903.

MALPHIGHIACEAE

Aspidopterys roxburghiana A. Juss.

Parlakimedi : hill jungles. *Burkill* 20481, Sept. 1903.

ZYGOPHYLLACEAE

***Tribulus terrestris** Linn.

Parlakimedi.

RUTACEAE

Glycosmis arborea (Roxb.) Corr.

Parlakimedi : *Burkill* 17927, Dec. 1902 ; *idem* 20553, Sept. 1903.

Murraya paniculata (Linn.) Jack. (*Murraya exotica* Linn.)

Parlakimedi : in sandy low hill jungles ; *Burkill, Grant & Candler* 20423 ; *Burkill* 20431, Sept. 1903.

Aegle marmelos Corr.

Parlakimedi : in jungle in valleys, reaching 3-6 m. high ; *Burkill* 20518, Sept. 1903 ; *Corey & Ramamurthy* 20152, 1903.

SIMARUBACEAE

Ailanthus excelsa Roxb.

Parlakimedi : common at the foot of hills. *Burkill* 17998, Dec. 1902.

***Brucea mollis** Wall.

Vern. Bauru, Baru (S.) ; Kosangi chettu (T.)
Parlakimedi : *Corey & Ramamurthy* 20149, Sept. 1903.

MELIACEAE

Azadirachta indica Juss. (*Melia azadirachta* Linn.)

Vern. Limma (S.) ; Vepa chettu (T.)
Parlakimedi : 30 m. *Corey* 20176, Dec. 1902.

Cipadessa baccifera (Roth) Miq. (*Cipadessa fruticosa* Blume)

Parlakimedi : *Burkill* 17925, Dec. 1902, and 20404, Sept. 1903.

HIPPOCRATEACEAE

***Salacia reticulata** Wall.

Vern. Kere (S.) ; Ankudu chettu (T.)
Parlakimedi : 609 m. *Corey & Ramamurthy* 20101. Sept. 1903.

CELASTRACEAE

***Gymnosporia rothiana** (W. & A.) Laws.
Vern. Konta bado (S.); Kanta bada chettu (T.)
Parlakimedi: 915 m. *Corey* 20127, Sept. 1903.

RHAMNACEAE

Zizyphus oenoplia Mill.
Vern. Kantelsi (S.); Parmingi chettu (T.)
Parlakimedi: *Corey* 20199, Sept. 1903.

***Zizyphus incurva** Roxb.
Devagiri: 304 m. *Burkill* 17978, Dec. 1902.

Zizyphus rugosa Lamk.
Vern. Tarmanda (S.); Pedda gotte chettu (T.)
Parlakimedi: 609 m. *Corey* & *Ramamurthy* 20118, Sept. 1903.

AMPELIDACEAE

Ampelocissus tomentosa Planch. (*Vitis tomentosa* Heyne)
Parlakimedi: in hill jungles; *Burkill* 20434, Sept. 1903.

Cissus vitiginea Linn. (*Vitis linnaei* Wall.)
Parlakimedi: *Burkill*, *Grant* & *Candler* 20416, Sept. 1903.

Leea robusta Roxb. (*Leea aspera* Wall.)
Vern. Kodoca (S.); Patadi chettu (T.)
Parlakimedi: 30 m. *Corey* & *Ramamurthy* 20187, Sept. 1903.

SAPINDACEAE

***Allophyllus serratus** Radlk. (*Allophyllus cobbe* Bl., in part).
Parlakimedi: *Burkill* 20405, Sept, 1903.

***Sapindus trifoliatus** Linn.
Vern. Karokai (S.); Kunkudu chettu (T.)
Parlakimedi: *Corey* & *Ramamurthy* 20192, 1903.

ANACARDIACEAE

Mangifera indica Linn.
Parlakimedi: abundant.

Semecarpus anacardium Linn.
Vern. Oloe (S.); Nallajeedi (T.)
Parlakimedi: 609 m. *Corey* & *Ramamurthy* 20113, Sept. 1903.

PAPILIONACEAE

Rothia trifoliata Pers.
Parlakimedi: *Burkill* 18000, Dec. 1902.

Crotalaria albida Heyne

Devagiri : in hill jungles, near the foot of hills. *Burkill* 17964, Dec. 1902 ; *Grant, Candler & Burkill* 20458, Sept. 1903.

Indigofera linifolia Retz.

Parlakimedi : very common in sandy places ; *Burkill, Grant & Candler* 20576, Sept. 1903.

Indigofera glandulosa Willd.

Parlakimedi : on dry situations. *Burkill* 20496, Sept. 1903.

Indigofera hirsuta Linn.

Parlakimedi : *Grant, Candler & Burkill* 20408, Sept. 1903.

Tephrosia purpurea Pers.

Parlakimedi.

Zornia diphylla Pers.

Parlakimedi : in grassy sandy places. *Grant, Candler & Burkill* 20502, Sept. 1903.

Aeschynomene indica Linn.

Parlakimedi : abundant. *Burkill* 20588, Sept. 1903.

***Pseudarthria viscida** W. & A.

Parlakimedi : among rocks in broken jungles. *Burkill* 20571, Sept. 1903.

Alysicarpus vaginalis DC.

Parlakimedi : in jungles in valleys. *Burkill* 20528, Sept. 1903.

Desmodium gangeticum DC.

Parlakimedi : in hill jungles ; on roadsides. *Burkill* 20462, 20479, 20539, Sept. 1903.

Abrus precatorius Linn.

Vern. Gujjibai (S.) ; Essa gulivinda chettu (T.)
Parlakimedi : *Corey & Ramamurthy* 20140, 1903.

***Stizolobium niveum** Kuntze

Vern. Dukka chikkudu (T.)
Parlakimedi : *Agent to Parlakimedi Estate* 34700, Aug. 1912.

Butea monosperma (Lamk.) Taub. (*Butea frondosa* Koenig ex Roxb.)

Parlakimedi : in jungles in valleys. *Burkill* 20531, Sept. 1903.

Butea superba Roxb.

Vern. Padam (S.) ; Moduga chettu (T.)
Parlakimedi : *Corey & Ramamurthy* 20193, Sept. 1903.

Phaseolus lunatus Linn.

Devagiri: on hillsides 609 m. *Burkill* 17958, Dec. 1902.

Phaseolus trilobus Ait.

Parlakimedi : *Burkill, Grant & Candler* 20581, Sept. 1903.

Dolichos lablab Linn.

Devagiri : *Burkill* 17983, Dec. 1902.

Dolichos biflorus Linn. (*Dolichos uniflorus* Lam.)
Parlakimedi : cultivated extensively. *Burkill* 18103, Dec. 1902.

Atylosia scarabaeoides Benth.
Parlakimedi : woods in the valleys. *Burkill, Grant & Candler* 20526, Sept. 1903 ; *Burkill & Candler* 17923, Dec. 1902.

Cajanus cajan (Linn.) Millsp. (*Cajanus indicus* Spreng.)
Parlakimedi, Devagiri : *Burkill* 17924, 17933, 17934, 17949, Dec. 1902.

Dalbergia lanceolaria Linn.
Vern. Padam (S.) ; Sagabotu chettu (T.)
Parlakimedi : 30 m. *Corey & Ramamurthy* 20181, 1903.

Dalbergia paniculata Roxb.
Vern. Padima (S.) ; Pachcheru chettu (T.)
Parlakimedi : 30 m. *Corey* 20177, Sept. 1903.

Pterocarpus marsupium Roxb.
Vern. Ame (S.) ; Egisa chettu (T.)
Parlakimedi : 610 m. *Corey & Ramamurthy* 20115, Sept. 1903.

Pongamia pinnata (Linn.) Pierre. (*Pongamia glabra* Vent.)
Vern. Karanja (S.) ; Kagu chettu (T.)
Parlakimedi. *Corey & Ramamurthy* 20143, 1903.

Derris scandens Benth.
Parlakimedi : on bushes in broken jungle. *Burkill* 20573, 1903.

CAESALPINIACEAE

Caesalpinia digyna Rottl.
Vern. Golaisi (S.) ; Nunegoru pikka chettu (T.)
Parlakimedi. *Corey* 20146, Sept. 1903.

Caesalpinia coriaria Willd.
Parlakimedi.

Cassia sp.
Parlakimedi : much planted on roadsides.

Cassia fistula Linn.
Vern. Baro (S.) ; Rella chettu (T.)
Parlakimedi. *Burkill, Grant & Candler* 20529, Sept. 1903 ; *Corey* 20109, Sept. 1903.

Cassia occidentalis Linn.
Vern. Kurtasakonda (S.) ; Gurraputantemu chettu (T.)
Parlakimedi. *Corey & Ramamurthy* 20195, Sept. 1903.

Cassia tora Linn.
Parlakimedi. *Grant, Candler & Burkill* 20406, Sept. 1903.

Cassia absus Linn.
Parlakimedi. *Burkill, Grant & Candler* 20575, Sept. 1903.

Tamarindus indica Linn.
Parlakimedi : very common.

Bauhinia racemosa Lamk.
Vern. Ombettasa, Ombetta kantal (S.) ; Areti chettu (T.)
Parlakimedi : 305 m. *Corey & Ramamurthy* 20138, Sept. 1903.

Bauhinia purpurea Linn.
Vern. Bondochaa nape, Baredab (S.) ; Botantem chettu, Gidugudu chettu (T.)
Parlakimedi : 610 m. *Corey & Ramamurthy* 20106, 1903.

MIMOSACEAE

Dichrostachys cinerea W. & A.
Vern. Kuraddibon (S.) ; Yetturi chettu (T.)
Parlakimedi : 30 m. *Corey & Ramamurthy* 20185, Sept. 1903.

Mimosa pudica Linn.
Parlakimedi.

***Mimosa rubicaulis** Lamk.
Parlakimedi : excessively common in rock broken jungles. *Burkill, Grant & Candler* 20559, Sept. 1903.

Acacia farnesiana Willd.
Parlakimedi.

***Acacia decurrens** Willd.
Vern. Tumma (S.) ; Tella tumma (T.)
Parlakimedi : 30 m. Introduced. *Corey* 20165, 1903.

Albizia odoratissima Benth.
Vern. Baran (S.) ; Gannenru chettu (T.)
Parlakimedi. *Corey* 20169, 1903.

CRASSULACEAE

Bryophyllum pinnatum (Lamk.) Oken. (*Bryophyllum calycinum* Salisb.)
Parlakimedi.

COMBRETACEAE

Terminalia catappa Linn.
Parlakimedi : planted.

Combretum decandrum Roxb.
Parlakimedi. *Burkill* 17922, Dec. 1902.

MYRTACEAE

Syzygium cumini (Linn.) Skeels. (*Eugenia jambolana* Lamk.)
Vern. Kurgad (S.) ; Neradi chettu (T.)
Parlakimedi. *Corey & Ramamurthy* 20137, Sept. 1903.

LECYTHIDACEAE

Barringtonia acutangula Gaertn.

Vern. Tira (S.) ; Kanapa chettu (T.)
Parlakimedi : 30 m. *Corey* & *Ramamurthy* 20184, 1903.

Careya arborea Roxb.

Vern. Kumbi (S.) ; Kumbhi (T.)
Parlakimedi : 30 m. *Corey* & *Ramamurthy* 20136, Sept. 1903.

LYTHRACEAE

Woodfordia fruticosa (Linn.) Kurz. (*Woodfordia floribunda* Salisb.)

Vern. Sinja nape (S) ; Thhathuva chettu (T.)
Parlakimedi : 30 m. *Corey* & *Ramamurthy* 20163, Sept. 1903.

Lagerstroemia parviflora Roxb.

Vern. Siddem (S.) ; Chennangy chettu (T.)
Parlakimedi, Devagiri. *Burkill* 17952, Dec. 1902. 609 m. *Corey* & *Ramamurthy* 20111, Sept. 1903.

PUNICACEAE

***Punica granatum** Linn.

Parlakimedi : planted and cultivated here and there.

CUCURBITACEAE

***Trichosanthes cucumerina** Linn.

Parlakimedi : in jungles on rocky hillsides. *Burkill* 20413, Sept. 1903.

Trichosanthes bracteata (Lamk.) Voigt. (*Trichosanthes palmata* Roxb.)

Parlakimedi : 45 m. *Burkill* 17928, Dec. 1902.

Coccinia cordifolia Linn. (*Cephalandra indica* Naud.)

Vern. Kotam (S.) ; Mandula mari chettu (T.)
Parlakimedi. *Corey* 20197, Sept. 1903.

CACTACEAE

Opuntia vulgaris Mill. (*Opuntia monacantha* Haw.)

Parlakimedi.

Opuntia dillenii Haw.

Parlakimedi.

UMBELLIFERAE

***Bupleurum plantaginifolium** Wight.

Devagiri. *Burkill* & *Candler* 17965, Dec. 1902.

RUBIACEAE

Adina cordifolia Hook. f.

Vern. Kadamba (S.) ; Patchi kamba chettu (T.)
Parlakimedi : not common in open dry jungles. *Burkill* 20569, Sept. 1903 ; *Corey* & *Ramamurthy*, 915 m. 20134, 1903.

Oldenlandia nitida Gamble (*Hedyotis nitida* W. & A.)

Parlakimedi. *Burkill* 20466, Sept. 1903.

Oldenlandia herbacea (Linn.) Roxb. (*Oldenlandia heynii* Br.)

Parlakimedi : common in sandy places. *Burkill* 20542, Sept. 1903.

Oldenlandia nudicaulis Roth.

Parlakimedi : in low hill jungles, in plenty. *Burkill* 20426, Sept. 1903.

Tarenna asiatica Gaertn. (*Webera corymbosa* Willd.)

Parlakimedi. *Burkill & Candler* 18101, Dec. 1902.

Randia brandisii Gamble. (*Randia dumetorum* Lamk.)

Vern. Patora (S.) ; Manga chettu (T.)
Parlakimedi. *Corey & Ramamurthy* 20156, Sept. 1903.

Gardenia latifolia Ait.

Parlakimedi : in hills at summits. *Burkill, Grant & Candler* 20483, Sept. 1903.

Knoxia corymbosa Willd.

Parlakimedi, Devagiri : in thin broken jungles. *Burkill* 17937, 17963, Dec. 1902 ; 20497, Sept. 1903.

Ixora coccinea Linn.

Vern. Korderi (S.) ; Puttapala chettu (T.)
Parlakimedi : 915 m. *Corey & Ramamurthy* 20129, Sept. 1903.

Pavetta indica Linn.

Vern. Kadumna (S.) ; Tellapapidi chettu (T.)
Parlakimedi. *Burkill* 20443, Sept. 1903 ; 915 m. *Corey & Ramamurthy* 20124, 1903.

Morinda tinctoria Roxb. var. **tomentosa** Hook.f.

Parlakimedi. *Burkill* 17989, Dec. 1902.

Hamiltonia suaveolens Roxb.

Devagiri. *Burkill & Candler* 17972, Dec. 1902.

Borreria stricta (Linn.f.) Schum. (*Spermococe stricta* Linn.f.)

Parlakimedi : in woods in valleys. *Burkill, Grant & Candler* 20522, Sept. 1903.

(*To be continued*)

The Earthworms : A Review

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(*With six text-figures*)

INTRODUCTION

The Earthworm is an animal only sometimes seen above ground and that, usually in the rainy season. Not possessing the charm of butterflies and other such insects it has escaped the attention of collectors. Having no superficial distinguishing characters it cannot provide the thrill of identification to the amateur naturalist. Even trained scientists conceal their ignorance under terms like ' some worms ', ' the common earthworm ', and so on. In fact, the earthworm appears destined to live and die in obscurity.

Nevertheless, earthworms merit serious study. Their role as soil builders is well known since the time of Charles Darwin and the knowledge of their medicinal importance has come down to us from the ancients. Their remarkable powers of regeneration have formed the subject of many elegant experiments in the early 20th Century. The last two decades have, however, introduced several novel concepts in science. New techniques have overthrown many a monument of classical scientific literature and, therefore, it becomes necessary to reappraise the biology of the earthworm in the light of contemporary work. It is hoped that the effort will be of interest to both the research worker and the amateur naturalist.

ZOOLOGY

1. GENERAL

The *Oligochaeta* are an order of the class CHAETOPODA. They are segmented worms possessing both male and female gonads. They deposit their eggs in a cocoon without a free larval stage. At sexual maturity they develop a collar-like tissue just behind the anterior segments, called the clitellum. There is no well-marked head but a preoral lobe called the prostomium is present.

The order is divided into a number of families, the majority being predominantly terrestrial and the rest mostly aquatic inclusive of a few marine species. It is convenient to group them according to size. Families which comprise the larger worms come under the *Megadrili* and the smaller ones under *Microdrili.* As a rule the former constitute most of the terrestrial forms and hence, in general, ' earthworms ' can be said to belong to this group. *Megascolids australis* is believed to be its largest representative, attaining a length of 11 feet with a diameter of one inch (Coleman 1944, Pope 1953).

Of the six families of earthworms found in India, Megascolecidae is the most widely distributed. This family has 30 Indian genera, of which *Pheretima* is the largest with 14 species, the last one being added by Gates (1945).

Considering the vast diversity of forms which can go under the term ' earthworm ' and regretting the confusion so caused, Stephenson (1930) remarks : " While on the subject of nomenclature, may I suggest, more particularly perhaps to some of the authors who write on physiological subjects (though morphologists are not invariably above suspicion in the matter), that they should identify, or get identified their material ? It is not always sufficient to talk of the ' earthworm ', there are 1800 species of earthworms, even in Britain there are nearly 40 species belonging to 8 genera. The ' common earthworm ' too, is meaningless—what is the common earthworm in one part of the country is not so in another . . . .". This comment is, unfortunately, as valid today as it was 30 years ago.

2. ANATOMY AND PHYSIOLOGY

a. *General*

The structure of the animal can be compared to a double-walled vacuum flask. The cavity between the two walls is called the coelomic cavity and is filled with fluid. The inner wall is the wall of the gut. The body is divided into a number of segments which makes it appear like a stack of coins or a number of similar rings. Animals with such structures are called *Annelids* from the Latin *a*(*n*)*nellus* meaning ' little ring '. Partitions, called septa, reach as far as the gut from the outer wall and divide the worm into a number of compartments. The coelomic fluid of each compartment communicates across the septa by means of pores which occur in a majority of segments. The forward and backward flow of the coelomic fluid causes reversible changes in the turgor of segments which facilitates locomotion by coordination with the muscles of the body wall. Only a few septa are imperforate (like the first 6 and those between segments 11-14 in *Pheretima posthuma*). Bahl (1919) was the first to prove that these apertures are sphinctered in the genus *Pheretima* and, in so far as the authors are aware, this has not been established in any other genus. Sphincters regulate the flow of the fluid by contraction and expansion.

b. *Coelom*

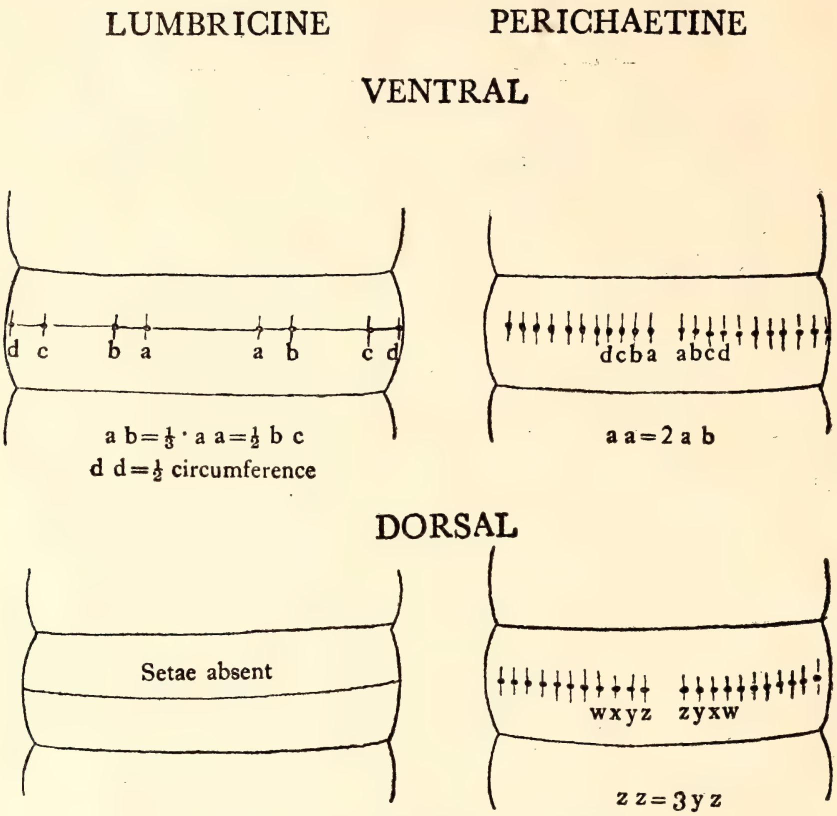
The coelom communicates with the environment by means of two types of apertures, the dorsal pores and the nephridiopores. The former are situated along the mid-dorsal line in each of the grooves between all the segments excepting a few anterior ones. These pores help in removing waste products from the coelomic cavity along with some albumen in the form of solid particles. They also help in maintaining moisture of the body surface. The situation of the first dorsal pore is a characteristic of systematic importance. The nephridiopores, on the other hand, are the exit pores of special excretory organs called nephridia, which remove waste products like urea and uric acid from the blood and the coelom. These tiny openings are situated along the lateral surface of the worm. When the nephridia open directly to the outside, the system is said to be exo-nephric, which is true for a majority of cases. In some genera, like *Pheretima* and *Lampito* some of the nephridia open into the gut. This is called an enteronephric nephridial system, and Bahl (1919) was the first to describe it in *Pheretima*. An interesting modification of coelomic fluid excretion is that exhibited by the squirter earthworm, *Didymogaster sylvaticus*, which shoots up a series of jets of the coelomic fluid a couple of feet into the air when disturbed. It is believed that it serves to plaster the burrow (Pope 1953) and perhaps it may also serve to frighten off predators.

c. *Setae*

Each segment is divided superficially into 2 rings by a central groove, called the setal groove because of the presence of bristle- or needle-like processes called setae whose number and distribution is of systematic importance.

Setal arrangement can be of 2 types, *Lumbricine* and *Perichaetine*. In the former the setae are arranged in pairs, 4 pairs to a segment (*Lumbricus*, *Eutyphoeus*). In the latter they are more in number and arranged in a continuous ring except for a dorsal and a ventral break (*Pheretima*, *Perionyx*). The size of the break in units of the distance between adjacent setae is also an important diagnostic characteristic. From the taxonomic point of view the Lumbricine arrangement is the more primitive one.

Each seta is developed from a pit on the skin and is slightly curved in shape. The tip or the ectal end is directed posteriorly. The basal


LUMBRICINE
PERICHAETINE
VENTRAL
d c b a a b c d
dcba abcd
a b=⅓·a a=½ b c
d d=½ circumference
a a=2 a b
DORSAL
Setae absent
wxyz zyxw
z z=3 y z

Text-fig. 1. Setal markings and formulae.

part is embedded in a sac, which is connected by two types of muscles—retractor and protractor. The setae can thus project out of the skin and get a hold on the substratum or withdraw and release its hold during locomotion.

d. *Body-wall and Locomotion*

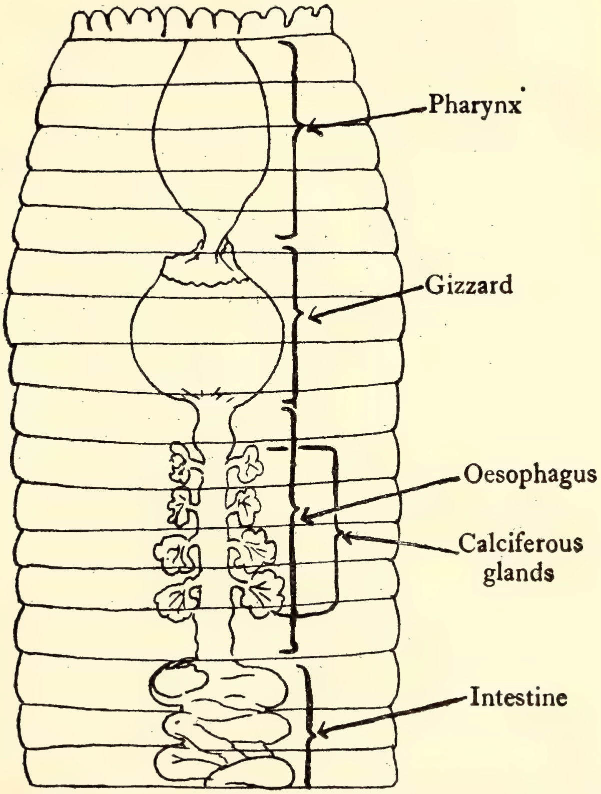
The body-wall consists of the outer cuticle-covered epidermis, internal to which are two muscular layers oriented at right angles to each other. The outer is circular, and the inner longitudinal. The inner layer is in contact with the coelom by means of the coelomic epithelium.

Locomotion is a function of the muscles of the body-wall. The anterior segments first contract the circular muscles, thereby relaxing the longitudinal ones and securing elongation towards the front (forward propulsion). The wave of contraction passes over backwards, when it goes past half of the way, the circular muscles relax and the longitudinal ones contract. This causes the segments to thicken and drive the ventral setae into the ground, holding on to the forward position till the rear portions catch up. These studies were made by Gray & Lissmann (1938) with cinematographic records. Further, it is believed that the expansion and contraction of the segments causes the propulsion of the coelomic fluid across the septa, thereby aiding locomotion.

e. *Digestion*

Aristotle aptly called earthworms the 'intestines of the earth', because they literally 'digest' the soil along with dead organic waste and convert it into readily available plant food.

The digestive system is relatively simple. It consists of the buccal chamber, pharynx, gizzard, stomach, and intestine. The minute quantities of organic matter in the soil are to be concentrated and hence enormous amounts of soil are to be taken in. The food, on its arrival in the pharynx, is acted upon by the saliva which contains mucin and a proteolytic ferment. It is then ground up by the thick internal cuticle of the muscular gizzard. The final digestion is by enzymes of the stomach



Text-fig. 2. Digestive system of *Hoplochaetella* sp.

and intestine which are of many types, viz. proteolytic, diastatic, hydrolysing, fat splitting, etc. The intestinal fluid corresponds to the pancreatic juice of higher animals. Digested food now passes into the blood stream through the intestinal epithelium, and the undigested matter mixed with large quantities of nitrogenous waste is excreted as castings. Waste products are collected by the nephridia and discharged as urine. The latter has an important secondary role of maintaining water by osmoregulation, which will be discussed later. Again, it contains ammonia, urea, and creatinine. The first two, at least, can nitrify in the soil with ease, thereby providing much needed 'available nitrogen' to the plants. Creatinine is also a nitrogenous compound which could be nitrified but along a longer route.

f. *Calciferous glands*

In many forms, the stomach epithelium produces glandular swellings on its walls which contain calcium carbonate and are thus called calciferous glands. Darwin regarded these as organs which secrete calcium salts to neutralize the humic acids of decomposing leaves eaten by the worm. In 1936, Robertson, on the other hand, came to the conclusion that their function is rather to excrete the calcium salts in the form of calcite crystals.

It must here be mentioned, that these glands are present only in the earthworm, though they may differ in complexity from species to species and may even be absent in some. Kelly has pointed out that the anterior and posterior pairs of glands contain lime of different types. In the anterior pouches, the carbonate is in crystalline form, whereas in the posterior pouches it is in amorphous form. X-ray studies by Voight reveal that the crystalline form is derived from the amorphous one.

Ohfuchi (1941b) in his studies on *Oligochaeta* from Micronesia suggested a biological relation between the calciferous glands and coral reefs of Micronesia. He worked with *Pontoscolex* and *Dichogaster*. Kashyap & Ranade (1952) compared the glands of *Pheretima* sp. with those of *Hoplochaetella suctoria* along with the calcium content and acidity of the respective soils and came to a conclusion similar to Darwin's.

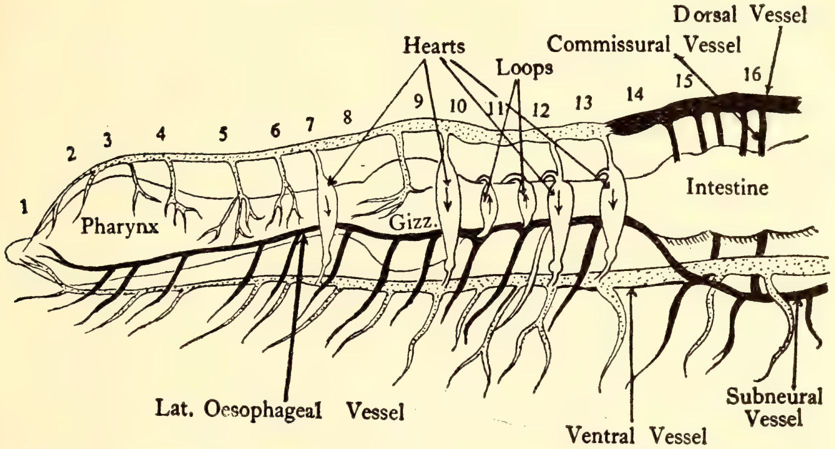
Joshi & Kelkar (1953) observed with some earthworms of Poona that the glands function in the rains and not in winter. They found the total calcium to be less in the casts than in the soil but water soluble calcium was more in the casts than in the soil. From this they attributed the novel function of plastering the burrow to these controversial glands.

g. *Chloragogen cells*

The chloragogen cells belong to the peritoneal layer of the intestine. They collect yellow refractive granules called chloragosomes, which are believed by some to be an excretion from the capillaries of the gut because they are known to drop off into the coelom (when full) and be excreted in the usual manner. Others believe that they function as nutritional reserves ; alternatively, in the absence of the liver they may be hepatopancreatic in function.

h. *Circulation*

The circulatory system is more efficient than that of Crustaceans or Molluscans. The absorbed food from the walls of the intestine is transported by the blood-stream through the posterior portion of the dorsal vessel which runs parallel to the long axis over the dorsal surface of the gut. Anteriorly, the dorsal vessel becomes a distributing vessel. It gives off 4 pairs of large pulsating vessels called the lateral hearts which bring the blood to the ventral vessel which distributes it to each segment. The dorsal vessel also sends a number of branches to the region of the 'head'. The blood from the various tissues of the body is collected by the subneural, the commissurals, and the lateral oesophageals. Waste products, mainly carbon dioxide and nitrogenous compounds, are eliminated through the skin and nephridia.



Text-fig. 3. Circulatory system in anterior segments of *Pheretima* (after Bahl, 1950). Diagrammatic

The blood is peculiar in that the haemoglobin is contained in the plasma and not in the corpuscles, which are colourless and nucleated. It is manufactured in the blood glands, which can be located in the 5th segment in *Pheretima posthuma.*

The ability of the animal to survive under anaerobic conditions is mainly due to the distribution of haemoglobin in the plasma instead of the corpuscles. The pressure of oxygen in the atmosphere is 152 mm. ; the haemoglobin in the plasma is readily able to absorb oxygen at much lower pressures. It is found that earthworm blood can get saturated with oxygen at pressures as low as 19 mm. According to one authority the coelomic fluid is at a pressure of 14 mm. and so the gas can be transferred from the environment to the inner tissues even when it is present in small quantities.

Carbon dioxide is released through the epidermis, which becomes permeable when moist. The moistening is due to the coelomic discharge and some secretion from the mucus glands of the epidermis. Mucus helps to conserve moisture, desiccation of the skin results in asphyxiation.

Earthworms can survive many hours in the total absence of atmospheric oxygen. Presumably, they are capable of anaerobic or intra-molecular respiration. This is, doubtless, a useful attribute for any animal destined to live buried in the earth. Anaerobic respiration usually results in the release of toxic intermediates. Thus, in yeast we have ethyl alcohol, whereas in intestinal worms it is valerianic acid. According to Stephenson (1930), Lesser (1908-1910) working with *Lumbricus terrestris* and *Eisenia foetida* found that starvation under anaerobic conditions produced a volatile fatty acid, supposed to be valerianic, since large quantities of glycogen were noticed to have decomposed during that period.

In general, accumulation of carbon dioxide depresses respiration, but in earthworms very little depression occurs even when the carbon dioxide concentration reaches 50%. This is another important characteristic which enables survival in the close proximity of respiring plant roots and micro-organisms of the soil.

Again, wounds accelerate respiration, at least in plants, and that is why two halves of a potato respire more than the entire tuber. In the earthworm, however, due to some nervous impulse the intensity of respiration actually decreases on wounding.

Stephenson (1930) refers to oxygen intake being hampered by ultraviolet light as was noted by Merker & Brauning in 1927 with *Lumbricus terrestris* and *Allolobophora calignosa*. This may be the reason for the lethal effects observed on radiation which first stimulates, then paralyses and finally kills.

i. *Nervous system*

The nervous system consists mainly of a ring of ganglia, which forms the anterior part of the nerve cord. The nerve cord consists of giant fibres capable of conducting impulses from one end to the other with great rapidity, which accounts for the violent wriggling on tactile stimulation, an important item of its pattern of escape from predators. Bending and jumping movements are also brought about in a similar fashion.

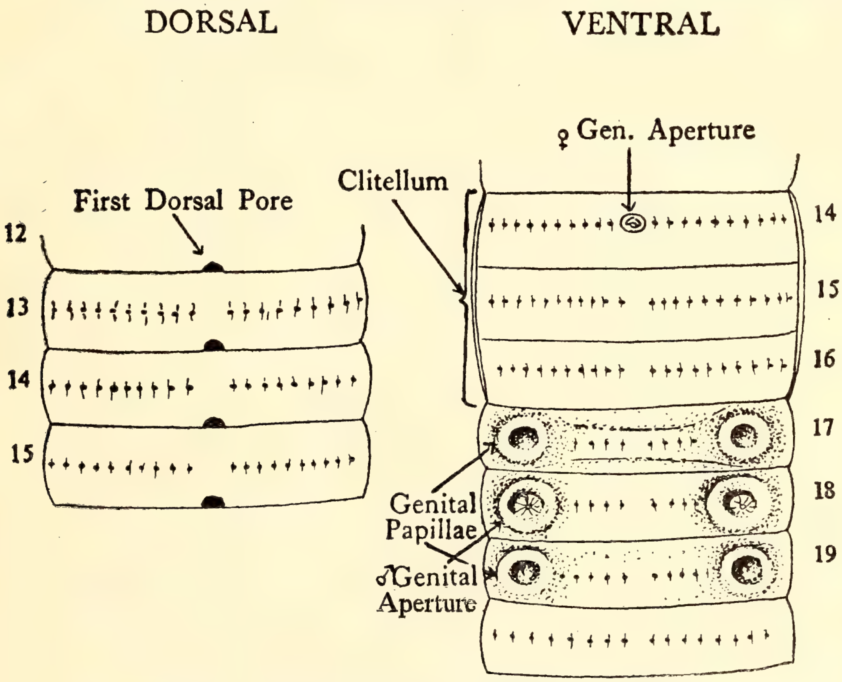
The velocity of nervous impulse in the earthworm is five times that in man, viz. 1970 feet (600 m.) per second. The oxygen consumption is also high. Winterstein & Basoglu (1939) found the oxygen consumption of the ventral nerve cord to be seven times that in frogs.

The cerebral ganglia also function as inhibitory centres. When they are amputated, the animal continues to move without stopping (wriggles indefinitely).

j. *Reproductive system*

The system shows many variations between ancient and modern forms. It will here be described in short, with reference to a few types. The reproductive system is so diagnostic that it is impossible to identify immature worms.

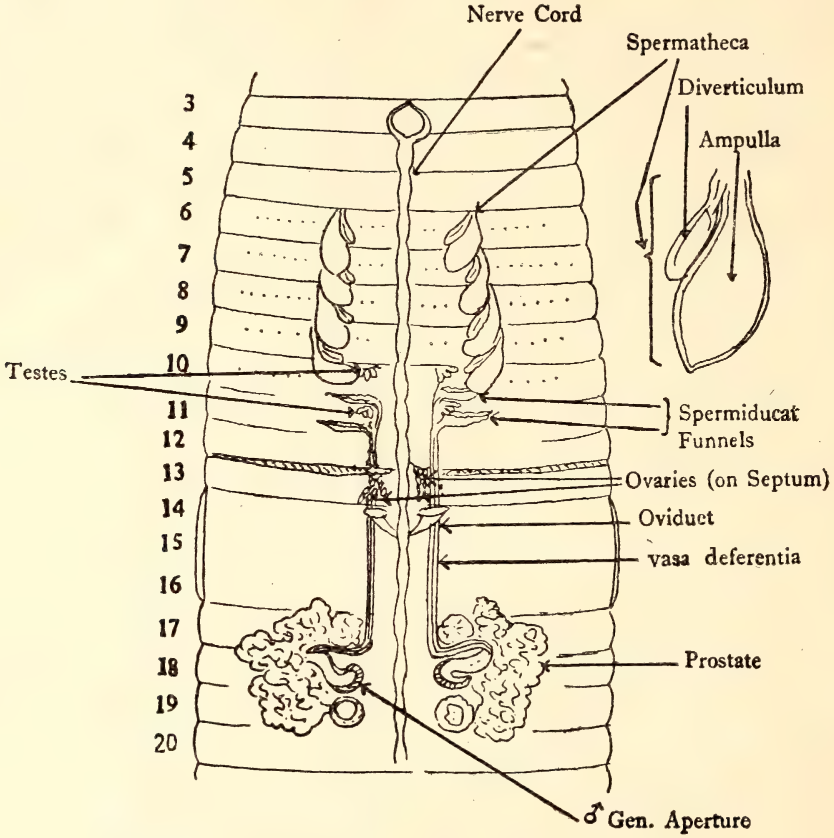
Earthworms are hermaphrodite. Impregnation is reciprocal, i.e. both pairing individuals mutually fertilize each other. Self-fertilization is impossible. Copulation has been completely followed only in a few species, but the following may be considered an illustrative trend.



Text-fig. 4. Surface markings of *Pheretima posthuma*

Each species has a number of spermatheca in its anterior segments (e.g. 4 pairs in *Pheretima posthuma* and 3 pairs in *P. houlleti*). In the former, a little behind the last pair of spermatheca is the female pore which opens on the ventral side of the 14th segment.

Segments 14-16 are thickened to form the collar called clitellum. A pair of genital papillae arise in each of segments 17 and 19, and a pair of


Nerve Cord
Spermatheca
Diverticulum
Ampulla
3
4
5
6
7
8
9
10
Testes
11
12
13
14
15
16
17
18
19
20
Spermiducal Funnels
Ovaries (on Septum)
Oviduct
vasa deferentia
Prostate
♂ Gen. Aperture

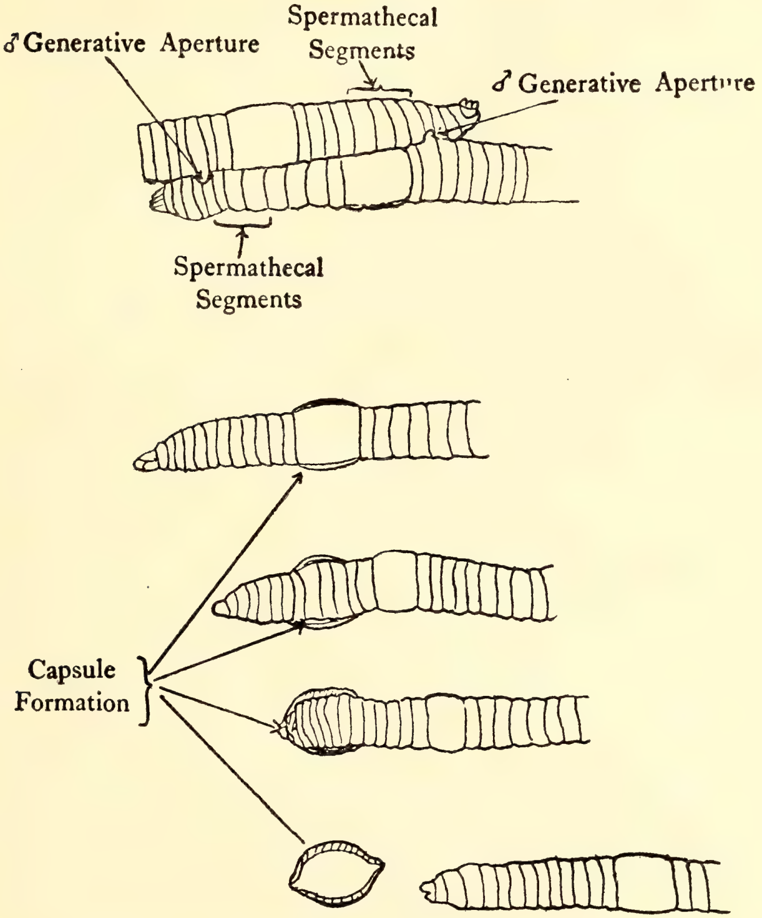
Text-fig. 5. Reproductive system of *Pheretima posthuma*
Note: Seminal vesicles and testis sacs removed to expose testes.

male generative apertures arise in the 18th segment. The female pore is connected to the oviduct which brings the ova from the ovaries (situated on the posterior surface of septum 12/13) as well as other secretions to it. Each male pore is connected to a rather thick tube which incorporates the tube from the testis (the vas deferens) and from the prostate gland (prostatic duct).

k. *Copulation*

The copulating animals lie with their anterior ventral surfaces attached but with their heads pointing in opposite directions. The male pores of one come in contact with the spermathecal pores of the other. The sperms and the prostatic fluid are mutually discharged into the posteriormost pair of spermatheca, where they are nourished by some fluid. By moving backwards the male pores discharge into the spermatheca next in line until all spermatheca are 'charged'.

The worms then separate, the clitellar segments of each gets enclosed in a secretion from the clitellum which ultimately hardens into a short tube. The animal then withdraws backwards through the tube and in doing so the spermatheca and the female pores discharge into the tube. To this is added some albumen from the anterior segments. The ends of the tube are sealed off when the worm is clear of it, thus forming the capsule or cocoon. It must be noted that the actual fertilization takes place in the cocoon and not in the worm. A technique for growing pure cultures of earthworms has been described by Tembe & Dubash (1959). Herlant-Meewi (1954) has described a method of securing artificial copulation and cocoon-laying in *Eisenia foetida*.


♂ Generative Aperture
Spermathecal Segments
♂ Generative Aperture
Spermathecal Segments
Capsule Formation

Text-fig. 6. Copulation and capsule-formation in *Pheretima*. Diagrammatic

l. *Parthenogenesis*

Cocoons can also be laid by individuals that have not paired but such cocoons normally do not develop. In some cases as in *E. rosea* the male organs are sterile thus exhibiting obligatory parthenogenesis. Parthenogenesis is maintained by polyploidy. In this case the animal is triploid (with $3n=54$ chromosomes). *Dendrobaena subrubicunda*, on the other hand, is a tetraploid ($4n=68$), which is facultatively polyploidal.

Polyploids provide variety and vigour due to the multiple chromosome number. Moreover, they can distribute themselves quickly over new areas and achieve a maximum population level without pairing.

m. *Asexual reproduction*

This has so far not been reported as a regular feature of true earthworms, but such modes have been noted in the aquatic forms (Microdrili). It is very common amongst some forms of the *Oligochaeta* (i.e. in the Aeolosomatidae, Naididae, and Lumbriculidae), mainly by fission, but these groups being largely aquatic come under the Microdrili which as such do not include true earthworms.

Thus in *Lumbriculus variegatus* (Lumbriculidae) sexual reproduction is rare but asexual reproduction takes place by fragmentation and subsequent regeneration. Similarly, Bell (1959) has written about a new species of naturally fragmenting worm called *Enchytraeus fragmentosus* which lacks sex organs.

n. *Regeneration*

All earthworms are known for their amazing powers of regeneration. One associates instantaneous death with decapitation. Nothing can survive without a head, except of course the earthworm! It can survive even after the removal of the first 15 segments and regenerate at least some of them. According to Roots (1956) regenerative capacity dwindles after the 9th segment and, no matter how many are removed, only 4 are regenerated. Posterior segments have greater power of regeneration than anterior ones. During caudal regeneration a long slender appendage of many segments is formed specially in the warmer seasons and the normal width is attained later. In *E. foetida* a whole ' tail ' can be regenerated even if only 13 anterior segments are left intact.

Although the nerve cord plays an important part in this process the head can be regenerated devoid of the nerve cord. If a worm is decapitated and the nerve cord diverted and made to emerge from a hole in the body, an extra ' head ' can be regenerated at the decapitated point.

In Lumbricids, at least, the sex organs show feeble powers of regeneration. In *Criodrilus lacuum* (Glossoscolecidae) some extraordinary powers of regeneration are reported. More than 20 segments may be regenerated at the anterior end inclusive of gonads, seminal vescicles, and ovisacs, though the male deferens apparatus is seldom reproduced. However, the number and shape of regenerated sex organs show great irregularities. Moreover, repeated regeneration occurs after repeated amputation. In 1896 Hescheler observed that repeated regeneration of the head of *E. foetida* may be observed up to a maximum of five times. The number of segments reproduced is, as a rule, not diminished.

In Microdrili, repeated regeneration is even more prominent. In 1908 Muller observed that the head of *Lumbriculus* could be regenerated up to a maximum of 17-21 times and the tail 33-42 times. Thus, the power of repeated regeneration seems to be twice as great at the tail as at the head. If both head and tail are removed simultaneously they may be regenerated 20 times. Recently, Gates (1959) working with *Lampito mauritii* Kinberg 1867, has recorded details about its anterior and posterior regeneration.

o. *Heteromorphosis*

This is the regeneration of a part in a different form from the original part.

In 1899 Morgan found with *E. foetida* that if it was cut in the middle, the posterior portion regenerated in the anterior direction but with a tail! The newly produced portion did not contain the cerebral ganglia or connectives and the nephridial funnels faced the wrong way round, i.e. towards the old tail.

Heteromorphy depends on the number of the segment at which the worm is cut. In 1904 Dimon found with *E. foetida* that, if the cut is anterior to the 17/18 septum, the regenerated part is a head, abnormal or otherwise. If the cut is at 18/19, the regenerated portions in a majority of cases are heads and very few are tails. Posterior to this septum the operation produces mainly tails and only a few heads. In general, tails are produced when the cut is posterior to the gizzard or in the intestine. Janda (1926) has recorded that in *Criodrilus lacuum* a head may be regenerated in place of a normal tail. Moreover, at the anterior end a triple regeneration might occur of a heteromorphic tail situated between two heads.

p. *Transplantation*

Some startling results have been observed by transplanting experiments of workers like Korschelt (1895), Rabes (1901) and Tirala (1912). If the head portion of one animal is sutured to the tail portion of another in the normal position, the gut, blood vessels, and nerve cords become continuous within a fortnight. Surprisingly enough, the union takes place even if one of the parts is rotated through 90° with respect to the other.

Again, two tails can be united resulting in a product which can survive for a long time. The union of two heads, however, is very rare and even then not long lasting.

Transplantation of ovaries has been accomplished by Harms (1910-12). The ventral portion of the septum 12/13 on which the ovaries are attached was transplanted from one worm to another, even of a different genus. A successful graft was the transplantation of ovaries of *L. terrestris* into *A. calignosa.* The resultant animal inclined to the ' mother ' in some characters and to the ' father ' in others. Some intermediate characters were also formed along with certain others not exhibited by either parent.

3. SENSES

a. *Perception of light*

Earthworms do not possess eyes, yet they can perceive differences between light and dark by virtue of a number of epidermal photoreceptor cells. Hess (1925) working with *Lumbricus* found these cells absent from the ventral surface and present in large numbers on the prostomium and the first segment.

It is commonly believed that earthworms are nocturnal feeders, but Roy (1957) from his work at Baranagore, near Calcutta, came to the conclusion that there was no significant difference in their casting activity during day and night.

Very often, worms can be seen outside their burrows after heavy rains, even in broad daylight, but in a paralysed state. Merker (1939) believes that they are driven out of their burrows by lack of oxygen when the tunnels are flooded and the paralysis is caused by the consequent exposure to ultra-violet rays. The same author working on the harmful effects of this radiation on tadpoles kept in distilled water came to the conclusion that calcium and sodium ions flowed out of the body within 15 minutes of exposure, and later even potassium followed. Under these circumstances, the life of the animals could be prolonged by adding a high concentration of calcium ions to the water. It is possible that a similar mechanism may be operating in the earthworm.

The question of why ultra-violet light is so harmful to some animals is worth speculating about, for this radiation serves important functions in other animals, e.g. it forms an important part of the light perceived by bees, to whom it appears as a true colour (along with 3 others, yellow, blue-green, and blue). The great attraction which bees have for inconspicuously-coloured flowers and for those with other colours (like red poppies) is due to the reflection of ultra-violet light from these flowers (Manning 1956). Mazokhim-Porshnyakov (1957) maintains that the same radiation plays a similar role in light perception by Lepidoptera.

b. *Sound, vibrations and touch*

Earthworms are not bothered by sound. The incomparable Charles Darwin found them oblivious of the piano, bassoon, and whistle as well as of shouts!

Though completely deaf, they are very sensitive to vibrations and tactile stimuli. Thus, one method of harvesting them is to produce vibrations in the soil by any suitable means. Darwin relates that a young peewit kept in confinement used to stand on one leg and beat the turf with the other in order to eat the worms which crawled out due to the vibrations.

Tactile stimulus is perceived by another set of epidermal receptors which are more numerous on the ventral and lateral surfaces than on the dorsal. Coupled with a sense of touch is an almost uncanny sense of discernment. When foraging for food, the grasping always follows a particular pattern, viz. leaves are held from the tips and not from the stalk. 2-needled pine leaves are grasped by the common base rather than from any of the tips. Darwin interpreted this habit to mean that somehow the animal was ' intelligent ' enough to select the most convenient end by which the piece could be drawn into the burrow. Since the same selective response was observed even with leaves entirely foreign to the country (no species of pine is endemic to the locality where he worked) he was reluctantly driven to postulate a degree of intelligence. These experiments were later extended by offering paper triangles where one angle was the sharpest. In a majority of cases they were always pulled in by the narrow end *without any previous trials with any of the other angles.*

Hanel (1904), on the other hand, was forced to a different conclusion from her experiments. She found that when leaves of the lime tree were so cut as to round off their acute apex they were still always grasped from that end although it was by no means a convenient (and, therefore, ' intelligent ') way to do so. Hence, she postulated a very sensitive chemical sense which enabled the animal to distinguish the extremely minute chemical differences between the anterior and posterior portions of the leaf. Even in the case of the pine leaves the response was said to be partly chemical. Her experience with paper triangles was also that it was the sharpest end which was most often chosen even when the differences between the angles was very small. The shortest side was most often avoided. The interpretation was that the worm crawls along the sides of the triangle and the succession of tactile stimuli which it receives as it crawls against the shorter side—angle—longer side—angle etc., evokes the reflex to select and grasp the narrow end. It thus appears that in trying to avoid accepting the notion of some degree of intelligence the author's conclusions seem to point to a knowledge of geometry!

Jordan (1912) who observed an undetermined Lumbricid at night with the light of a kerosene lamp failed to find any crawling around leaves. He reported that leaves were first held by their surface by creating suction with the pharynx and later pulled in by any end.

c. *Chemical sense*

Contemporary work has established a well-defined chemical sense with thresholds similar to or below those of Man. Mangold (1951) extended the pine leaf experiments by first making them tasteless by extraction with organic solvents. The needles were tied into small bundles, one end was covered with aqueous gelatin solution and the other with test substances in the same solution. The animals were kept in a terrarium and a record was maintained of their choice. The test substances were slurries of decayed leaves of various species. The order of preference was Gelatin > Willow > Sweet Lupine > Walnut > Acacia > Poplar > Oak > Bitter Lupine > Linden > Beech > Cherry > Maple > Horse Chestnut. (The sign > indicates ' preferred to '.) Quinine and Hydrochloric Acid were avoided, whereas dilute solutions of organic acids, sugars and even saccharine were preferred to gelatin.

d. *Taste and Smell*

Linked with the chemical sense is the one of taste. Roots (1956) has recorded that *L. terrestris* showed a marked preference for certain food when offered a choice. Chocolate is preferred to meat > celery > wild cherry > wild carrot leaves, while leaves of the plane tree, mint, and thyme are not touched. The sites for sense organs capable of perceiving the stimuli of chemicals, taste, and smell are on the buccal epithelium, which comes in contact with various substances during feeding by the constant eversion of the buccal chamber (Bahl 1950).

e. *Electrical stimulus*

Earthworms are galvanotactic but in a sense opposite to Vertebrates and Crustacea. Moore (1923) and others have found that under electrical stimulus they become U-shaped with both ends directed towards the cathode. Reversal of current produces a reorientation towards the new cathode. Under a similar stimulus Vertebrates and Crustacea orient towards the anode.

4. BEHAVIOUR

a. *Feeding*

The food is first moistened by an alkaline enzymatic secretion which digests starch and thus makes it easier to tear into shreds. Leaves may be torn by holding them by the edge between the prostomium and the mouth and pushing the pharynx forward. Alternatively, small portions may be sucked in by first pressing the mouth against the leaf and then withdrawing the pharynx, thus producing suction.

b. *Burrowing*

The earthworms create tunnels through the soil as they move. They first push their anterior portion into a crevice and then bore in by expanding their segments and forcing apart the obstructions. When the soil is very compact they literally eat their way through. The burrows are usually plugged with anything that is handy, and the strength that is brought to bear on this operation is truly phenomenal. Barret (1955) records that a worm weighing 1/30th of an ounce can shift a stone weighing 2 oz. which is equivalent to a man of 150 lb. shifting a load of 4 tons!

Scarcity of food or water causes a stimulation of burrowing activity which may extend to a great depth. Bahl (1950) quotes Bourne as having obtained specimens of *Drawida grandis* at a depth of 9-10 feet (2·7 to 3 m.) in the Nilgiris in the month of May. Different species burrow at different depths varying from a few inches to several feet.

Burrowing habits can be studied by keeping the animals along with some soil between two plates of glass placed close enough for observation from both sides. Garner (1953) used the following method for a study of various tunnelling animals in the field :

Liquid latex thinned with ammonium hydroxide is diluted 1 : 8 with distilled water and poured into the tunnels. The latex hardens into a cast of the tunnelling system in 2-3 days. He has observed that earthworms of garden soil near Richmond, Indiana, made a complex maze of horizontal tunnels, an inch (2·5 cm.) below the surface, and these were connected with other similar horizontal systems further down, by vertical shafts. These vertical shafts penetrated 2-3 feet (60-90 cm.) into the C-horizon of the soil. The tunnels were lined with mucus which served as a substratum for fungi. The fungi attracted ants, which used the upper tunnel shafts as entrances to their nests.

All earthworms do not live in the earth. Some have adapted themselves to other substrata. Thus *Perionyx* thrives under aerated water and *Pheretima musica* lives on the tree trunks in Java, using the humus of the epiphytic ferns. Species of *Dendrobaena* and *Mesenchytroeus* live midst ice and snow (Bahl, 1950). There are some species of *Pheretima* living in caves. Such types are known as cavernicolous. Cave living lengthens the period of immaturity and induces hibernation, besides showing lack of pigmentation (Ohfuchi, 1941a).

c. *Casting*

After passing through the animal, the food emerges as a compact, concentrated mass termed casting. Some species cast within their burrows and others on the surface. The form of casting may vary from individual pellets as in *Pheretima posthuma* to short threads in *Perionyx millardi*. In some cases the worms produce a thick and long winding column which produces a hollow mound about 2 inches long (5 cm.) and an inch (2.5 cm.) wide. *Hoplochaetella khandalaensis* is known to produce such casts. *Dichogaster jaculatrix*, an African worm, is reported to produce red clay chimneys which may be 4-5 inches (10-12 cm.) high and about 1½ inches (4 cm.) wide. Perhaps the biggest recorded castings are those of *Notoscolex birmanicus*, noted by Gates in Burma. One such casting, even after 4 months of drying in rainless weather weighed 3½ lb. (1.6 kg.) and was 150 mm. high.

There is a tendency amongst workers to use the form of castings to identify worms, which is rather unfortunate. There are many other worms, besides those mentioned above, which produce similar casts. Again, different species may co-habit under a prominent system of casts, thus confounding identification. Moreover, even commensal relationships have been reported, at least in one case. Thus Saussey (1957) observes that *Dendrobaena mammalis*, which is a small Lumbricid, lives commensally in burrows with *Allolobophora terrestris* and *A. longa.*

5. ARCHAEOLOGY AND EARTHWORMS

This is perhaps the least suspected of all the roles of the earthworm.

The fact that earthworms have an important bearing on archaeological interpretations was first pointed out by Darwin. They constantly remove soil from below archaeological monuments and cast it on the surface thus securing a premature burial but at the same time protecting them from the ravages of the elements. Extensive observations of ancient relics at Stonehenge and many Roman excavations by Darwin led him to this view, which has again been brought into prominence very recently.

It is believed that by continuously shifting soil, specially in the first 12 inches (30 cm.) of the surface they are responsible for misdating of ancient monuments. Thus they are a force to be reckoned with in all archaeological findings. The British Association is reported to have set up a committee on archaeological field experiments with a view to study denudation and soil movement. These aspects have been recently reviewed by Jewell (1959).

6. INTELLIGENCE

The deaf, dumb, and blind earthworm, nevertheless, seems to be endowed with some exceptional 'mental' powers.

Darwin observed that animals which were either feeding or copulating could not be distracted by light, which would otherwise irritate them.

The earthworm is also capable of learning from experience, an attribute unfortunately deficient in many humans. When provided with a choice of two paths it can be taught, by experience, to choose one of them. Robertson (1953) used a T-maze of the following dimensions for experiments on *L. terrestris*:

A straight arm (25.4×2 cm.) led vertically into a horizontal tube junction whose left arm was 10.1 cm. and the right 15.3 cm. in length. The left arm, which represented the negative goal terminated in very rough sand paper followed by electrodes capable of giving a shock of one volt. The other arm (+ ve goal) led to a beaker with moist soil and moss and covered with paper to prevent light. The floor of the maze was lined with moist blotting paper which was changed frequently to prevent the formation of tracks. The worms can be made to enter the straight arm and prevented from turning back by directing light towards the entrance. After repeated trials, a bias is established in favour of the more suitable path—the lesson is 'learnt'!

Yerkes (1912), who was amongst the pioneers of this type of study, came to the astonishing conclusion that this lesson is retained even when the first 5 segments (including the cephalic ganglia, i.e. brain) are removed. More astounding is the fact that, when a new brain is regenerated, this learning is forgotten.

Where is this lesson 'stored' and how does the regenerated brain succeed in effacing this knowledge?

7. Distribution & Ecology

a. *Dispersal*

Earthworms by nature are not wanderers. They seldom leave their locality except with the onset of adverse factors like drought or attacks by predators. They are generally localized by soil conditions yet many species have become world wanderers having been dispersed by biotic agents. They may be carried in the hoofs of cattle and in the transfer of soil and manure. Botanical gardens thus become centres for collection and distribution of various species throughout the world. Species which are widely distributed are called 'peregrine', e.g. the Lumbricids, which were originally natives of Europe, are now distributed all over the world. Even *P. posthuma*, which is a well-known type in our Indian Universities, is regarded as peregrine by Stephenson.

b. *Geographical distribution*

Gates (1947, 1951) has observed their distribution in the Allahabad sector of the Gangetic plain and in some Himalayan hill-stations and their environs. With regard to the latter, he concludes that the family Megascolecidae predominates at Sahranpur and Dehra Dun whereas in Simla, Mussoorie, and other Himalayan localities the Lumbricidae predominates and, further, that in the hilly areas the native species are almost entirely replaced by the European Lumbricids.

c. *Edaphic factors*

In spite of the adaptability of many species to different habitats, some are known to be restricted to certain soils.

i. Soil acidity

Satchell (1955), working on the effect of soil acidity on distribution, found that *Bismastus eiseni, Dendrobaena octaedra,* and *D. rubidia* were acid tolerant. *Allolobophora calignosa* was one of the four species which could not tolerate acidity, whereas *Lumbricus terrestris* and three others were ubiquitous.

ii. Soil cover

Distribution with regard to soils under cover of different herbs, shrubs, and trees has been studied by Ronde (1951), whose findings revealed that spruce and pine had fewer worms, both in number of species and total weight, than ash, birch, and other hardwoods. *Sambucus* sp. and *Oxalis acetocella* were said to be very favourable to worms, whereas *Sphagnum* showed complete absence of the animals. Considering their ability to select particular leaves and also bearing in mind their acute chemical sense, one can say that a part of their distribution, at least, is due to this quality.

iii. General soil factors

Waters (1955) correlated the abundance of *A. calignosa* and *L. rubellus* with soil temperature, moisture, and supply of plant residue. He found that temperature variations produced negligible effects on population, but high moisture content in association with poor aeration was very harmful to their numbers. Fluctuations in the number and weight of the animals were correlatable to the increase or decrease of the supply of plant residues.

iv. Soil moisture

It is also reasonable to expect available moisture in the soil to be a factor in their distribution. As a rule they do not thrive in dry soils and avoid drought, either by migrating to lower layers several feet deep or by entering a state of diapause in which they roll up inside spherical earthen cells lined with mucus. Here, too, some differences are reported between species of the same genus by Roots (1956). She observes, for instance, that *A. calignosa* and *A. chlorotica* enter diapause only under unfavourable conditions, whereas *A. terrestris* f. *longa* and *A. nocturna* spend the summer months in this way. The ability to survive in dry soils raises questions on their moisture content and the proportion of their body water that they can afford to lose.

Grant (1955a) found the water content of *A. calignosa*, *E. foetida*, and *P. hupeiensis* to be from 82-85% of body weight. Their respective vital limits for desiccation were 63.5, 58.8, and 48.6% loss of body weight due to loss of water. These figures could be compared very favourably with humans, and even with the camel which is well-known for its ability to survive without water for months.

Schmidt-Nielsen (1959) indicates that in man a loss of water equal to 5% of body weight causes deterioration in his physical condition, distortion of vision, and a clouding of judgment. A 10% loss brings delirium, deafness, and insensibility to pain. In desert heat a loss of 12% results in ' explosive heat death ', because the blood becomes too viscous to circulate freely and thus the metabolic heat is not dissipated sufficiently. In cooler surroundings he may barely be able to survive a 20% loss of water. The same author experimentally proved that a camel in the desert could withstand a loss of 25% water.

Excess of water is also a factor of consequence. Most species of earthworms cannot survive flooding, though a fair number can do so, provided the water is aerated. It is a familiar sight to observe earthworms of the genera *Perionyx* thriving in rain-fed gutters of Bombay. Incidentally, the genus is easy to identify from its coloration which is a darkened red on the dorsal surface and white on the ventral surface. Moreover, they are not round but slightly flattened in transverse section. Amongst other species able to survive in soil totally submerged in aerated water are *A. chlorotica*, *A. terrestris* f. *longa*, *L. terrestris*, and *L. rubellus* (Roots 1956).

Different responses towards flooding raise interesting questions in osmoregulation and conservation of water. When two osmotic solutions are separated by a semi-permeable membrane, water flows from the more dilute solution to the other until both are of equal concentration. In living osmotic systems, however, there are devices whereby concentrated solutions can be retained against an osmotic gradient. This is true of plant roots, sea algae, and many others.

An earthworm in contact with soil water represents a biological osmotic system. Its coelomic fluid is separated from the environmental water by the skin which is semi-permeable to a degree. Since the fluid contains about 98% water it is capable of exerting an osmotic pressure. Bahl (1950) regarded it as a reservoir of water. Its discharge as urine is said to be an arrangement for prevention of flooding by the external water. Again, where the nephridial system is enteronephric, the release of a part of the urine into the gut is an arrangement to conserve water, which can be reabsorbed from the urine by the intestinal walls. This type of ' water economy ' probably achieves its extreme limit in the

Kangaroo Rat, which produces urine with so little water that it solidifies as soon as it is excreted (Schmidt-Nielsen, 1959).

Roots (1955) in her studies on the effect of osmotic concentration of bathing fluids on the nephridiostome cilia of two worms, *L. terrestris* and *A. chlorotica*, found that their distribution depended on the differences in their ability to withstand osmotic forces from the environmental medium. The nephridiostome cilia of the former, which is purely a terrestrial animal, could not withstand as much diluting of the bathing fluid as those of the latter, which are found both in soil as well as submerged in lakes. Again, the former could resist hypertonicity better than *A. chlorotica.*

From the above it will be clear that osmotic relations of earthworms form an important complex with the excretory systems on which depends their distribution in soils of different water content.

EARTHWORMS AND MAN

1. SOIL FERTILITY

The outstripping of food resources by increasing population is the problem of the day. The 'explosions' of population that occur in various parts of the world intensify demands for increased food production. The layman imagines, that in an industrial era it should be easy to grow more food by increasing the production of chemical fertilizers. But, unfortunately, the demand for fertilizers is far in excess to the potential supply. Dhar (1959) argues that in order to feed a world population of 2700 million people 1100 million tons of food is required, which works out to a demand of 100 million tons of fixed nitrogen. Chemical technology can contribute only 7 million tons, legumes 5 million tons, and precipitation 10 million tons to the world soils, leaving a large deficit to be made up in any feasible way. Unfortunately, large quantities of nitrogen are lost to the land as sewage and rubbish. The same author has calculated that 4-5 million tons of nitrogen are lost in this fashion, which is almost equal to the quantity added as nitrogenous fertilizers. He, further, mentions that the 4000 million acres of cultivated land in the world are likely to suffer a loss of at least 50 million tons of nitrogen per year in crop production, and advocates that these losses be compensated in permanent agriculture by natural methods of recuperation. It is no wonder that Leibig attributed the fall of the Roman Empire to the loss of nitrogenous compounds in the sewers of the capital.

Earthworms can thus serve an important function by providing fertilizers from wastes. They have been cultivated intensively in breeding farms, from where stocks of particular types are sold. An anonymous report (1954) says that Germany's first earthworm farm was started in

1953 inspired by similar enterprises in California. A box of 100 worms costs about 1.5 DM. (or about Rs. 1.75), though they are cheaper by the thousand and cheapest as spawn. The output for some California farms is 500,000 worms a day. By their activity they are reputed to be useful for drainage of flooded areas. After the Netherlands flood catastrophe several million earthworms are said to have been delivered by California farms for use in reclaiming such areas.

Grant (1955b), however, points out that one species commonly supplied by earthworm farms, namely *E. foetida*, being used to manures and compost cannot survive for long in a field or garden. Thus any increase of yield is short-lived and due mainly to the decomposition of the dead worm rather than to its activity. He also doubts their use in flood control.

It is noteworthy, that a given area of soil can support only a certain size of worm population. Hence, mere addition of living worms to a soil will not necessarily help unless the worm-load is low or worm-food (waste, straw, etc.) is added along with it. Addition of castings is, however, always beneficial.

With respect to the soil, the role of the earthworm is twofold : (1) what it does to the soil when living, and (2) what it contributes on death. In the living condition it brings about favourable physical and chemical changes in the soil. By tunnelling it procures aeration, and thereby helps in respiration of roots. Absorption of salts by plant roots is an energy-consuming process, and some of the energy at least is provided by respiration. Hence, one can expect greater absorption in the region of the tunnels. Their action is comparable to a conveyor belt, which brings up the unaerated non-nutrient deeper layers of soil and in doing so converts it into an excellent manure which is deposited on the surface as castings. Roy (1957) has reviewed the data on quantities of castings produced by earthworms in different parts of the world, and has compared it to that of some Indian species in Calcutta and Bihar. Thus, Darwin (1881) estimated the annual tonnage per acre to be 7.5 and 16.1 in two localities in Yorkshire. The maximum estimate reported by Roy is from the work of Beague (1912) who estimated it to be 107 tons per acre per annum in the valley of the White Nile. The mean annual value for castings at Baranagore (Calcutta) grasslands estimated by him is 31.02±6.08 tons per acre. Similar studies at Giridih (Bihar) revealed the very low figure of 1.4±0.51 tons per acre.

Lunt & Jacobsen (1944) have very ably summed up the necessary literature up to 1944 and conducted comparative chemical and mechanical analysis of unworked soil and castings. They record that in field soils the casts had higher pH values and were higher in total and nitrate nitrogen, organic matter, total and exchangeable calcium, exchangeable potassium and magnesium, available phosphorus, base capacity, base saturation, and moisture equivalent. Forest soil samples showed even more striking results.

Hopp & Slater (1948) using unproductive subsoil obtained large increases in yields of grass and clover by inoculating with live earthworms as compared to controls where the same weight of dead worms were added. Jacks (1950) in reviewing the role of soil fauna in soil formation indicates that, formerly, the main agents for soil formation were supposed to be micro-organisms, but now the emphasis has shifted to macro-organisms like insects, arthropods, and earthworms, which taken together are more important as soil-builders. He cites the work of Kuhnelt (1950) indicating that plant residues have first to pass through several animals before they can be made available to micro-organisms, and that the material may have to pass through several animal bodies before being finally available as humus.

Earthworms considerably improve the physical structure of the soil. Thus, Jacks refers to Frei (1948), who found that inoculation of weakly cohesive soil with the animals causes a sponge-like structure to form in a short time. Similarly, Swaby (1950) observed a greater structural stability of earthworm casts from grassland as compared with those from adjacent cultivated soil. It was concluded that binding substances were derived from grass roots during their passage through the worms. Grassland casts contain exceptionally high numbers of bacteria, which might have produced gums gluing the soil particles together.

A comparatively new angle is the claim made by Hopp & Slater (1949) that certain beneficial chemicals are released from the bodies of earthworms which increase crop yields. Nijhavan & Kanwar (1952) have studied the physico-chemical properties of earthworm castings and their effect on soil productivity in the Panjab. In general, beneficial results have been reported. Joshi (1954) has indicated increase of nitrification due to the effect of earthworms. French *et al.* (1957) have studied the nutrient composition of earthworms from the point of view of food for migratory birds, and have found it to be 83% moisture, 8-9% protein, 3% ash (minerals), 3% carbohydrate, 1% fat and 1 cal/g energy. This indicates the amount of nutritive material alone which is returned to the soil on death, not to mention the various enzymes and bacteria that help to make it available.

2. BIOCHEMISTRY AND MEDICINE

a. *Ancient*

Ancient medical lore is full of the uses of earthworms, both the extract as well as the ash being in demand for a variety of disorders. Stephenson (1930) mentions the work of Hamidullah Mustaufi of Quazwin the NUZHAT-UL-QUTUB (A.D. 1340), which includes recipes for ejecting stone in the bladder and for the treatment of a number of ailments like jaundice, difficult labour, and sexual debility. He also quotes from HAYAT-UL-HAYAWAN, an Arabic treatise written in A.D. 1371 by Damiri, where the animals are used in the treatment of piles.

Knowing the difficulties of identification, one can almost certainly venture a guess that a variety of animals with different taxonomic opsitions must be finding their way into the medications.

b. *Modern*

In modern times, however, their uses have become more specific and well defined. The following are some of them.

i. Earthworms and Micro-organisms

The intestinal microflora has great possibilities for microbiological investigations. In general it may be said that, though the nitrifying organisms do not show any significant increase in passing through the animal, it is reasonable to expect a higher degree of nitrification of the casts because of enrichment with starting substances and improvement of the soil structure. Another aspect of importance is their ability to spread disease. Since they live in soils enriched with night soil, one would expect them to carry intestinal pathogens from human sources, but Khambata & Bhatt (1947) working with *Pheretima* spp. maintain that even *E. coli* was absent from the intestine (except one strain isolated from cellulose enrichment). They further suggest that intestinal secretions prevent the growth of such pathogens and thus *Pheretima* sp. at least, cannot be guilty of spreading any human infection of the intestinal tract.

Other organisms of the intestine have been investigated by a number of workers. Many of the organisms found in the intestinal tract are antibiotic. Thus Ruschmann (1953) in Germany found that several species of actinomycetes amongst which were *Streptomyces coelicolor* and *Nocardia polychromogenes* predominated in the casts. Variable antibiotic activity was shown against Gram-positive bacteria. Kobatake (1954) found that earthworm extracts were antibacterial in vitro against human type tubercle bacteria, several strains of non-acid-fast pathogens, and saprophytic mycobacteria. A petroleum-ether extract was bactericidal at a dilution of 1 : 1000 and bacteriostatic at 1 : 3200. Bhatt and his co-workers in India are the leading researchers on the intestinal microflora of the Indian earthworm. Amongst other aspects, they have recorded the presence of various unidentified species of *Streptomyces*, some closely related to *S. cellulosae* from the intestines, which were shown to decompose oxalate when grown in liquid oxalate medium containing 0.1% yeast extract. Tracey (1951) has found that extracts of some species of earthworms produce cellulase and chitinase. It is believed that these enzymes probably originate from the worms rather than from intestinal organisms. Recently, Brusewitz (1959) working with *E.foetida* found that the number of micro-organisms in the castings depends upon the nature of food material present in the soil. The number decreases with easily digestible material like glucose and increases with the more complex plant residues. Some other findings of the same author are that *Escherichia coli* cells inoculated into the soil were suppressed by earthworms. Again, soils with earthworms were found to contain more Vitamin B_{12} than controls. This increase, however, is shown to be microbial in origin. Materials toxic to plants such as 2, 4-D were destroyed more rapidly in earthworm infested soils due to activities of micro-organisms. Vendt (1953), in his investigations on the Vitamin D content from various invertebrate sources found that, on a dry weight basis, freshwater molluscs contained 0.13-0.032%, snails 0.08%, silk-worm cocoon 0.06%, and earthworms 0.04-0.1% of Vitamin D. The antifungal properties of earthworms have been exploited in a novel way by Smith *et al* (1952) in Calcutta. In the breeding of the mite, *T. deliensis* (Walch), fungus infection is found to be a major problem. These authors have, however, discovered that there is no fungus growth if a few species of the genus *Enchytraeus*[1] are kept in the breeding tubes. In practice, stock cultures of the earthworm are maintained in tubes with an inch (2.5 cm.) of moist sand at the bottom. Mosquito eggs, decaying leaves, and rotting filter paper are used as food. A few worms are then transferred to breeding tubes.

ii. Earthworms as laboratory animals

At least two main uses appear to be indicated from contemporary literature, viz. as test animals for pregnancy and for carcinogens. For the former tests, Hasenbein (1951) used urine concentrated according to Zondek 5 : 1 which was injected subcutaneously into the earthworm. Smears were taken from the seminal vescicles, before and after the injections, for spermatogenesis. 90% accuracy is claimed for this method. The effects of carcinogenic hydrocarbons on the skin of earthworms has been observed by Gersch (1954). He found that Benzopyrine (0.5%), dimethylbenzanthrene (0.5%), and other compounds, when applied in Cetiol on *L. terrestris* for several weeks, induced tumours.

Considering the relative simplicity with which earthworms can be cultivated in large numbers at practically no cost, it is surprising that their use in this direction has not been further exploited.

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[1] According to Stephenson (1923), 'all Indian species so far described are aquatic.'

3. OTHER MISCELLANEOUS USES

Earthworms are of course well known as fish food, both as baits and for feeding aquarium fish. There is even a report that they are fit for human consumption. The Maoris consider them a delicacy. Perhaps a bit of research may be required to make them palatable to civilized tastes.

4. EARTHWORM AS A NUISANCE

It is only fair to mention some points against the earthworm that have been recorded so far. The main complaint is against their habit of casting on turf, lawns, and golf greens, thus rendering them unsightly and useless. *P. hupeiensis*, indigenous to the mainland of China, appeared in epidemic proportions in golf greens in Westchester County, N.Y., and Fairfield County, Connecticut, in 1948. A research project was, therefore, initiated to study its biology and burrowing habits. The extent of its activity can be gauged from the fact that Schread (1952) estimated the amount of earth cast up annually on golf greens by this species alone to be over 18 tons. No estimates of the corresponding deterioration of golf scores are provided!

There are also indications that the animal may be guilty of spreading certain diseases of poultry. Allen (1950) inoculated *L. terrestris*, species of *Allolobophora*, and *E. foetida* with embryonated eggs of *Capillaria annulata*, to test their ability for transmitting this parasite to chicken. *L. terrestris* and all others except *A. longa* were found to act as intermediate hosts. Again, the spread of some soil fungi is reputed to be increased by the activities of earthworms, as can be seen from the work of Hutchinson & Kamel (1956) in Glasgow. In our own country Khambatta & Bhatt (1947) working with some Indian earthworms, mostly *Pheretima* sp., came to the rather disturbing conclusion that earthworms could spread plant pathogens like *Fusarium* in the soil. Agarwal *et al.* (1958) claim that some species of *Allolobophora* excrete a waxy fluid which adversely affects soil structure and productivity of soils in Himachal Pradesh. This claim is rather difficult to substantiate since at least one species of the genus, viz. *A. calignosa* (Savigny) f. *trapezoids* (Dug'es) has been reported by Khalaf El-Duweini (1941) to be the most abundant in cultivated soils of Egypt as well as in other parts of the world. Similarly, Barley (1959) working in Adelaide observes that *E. rosea* (Sav.) and *A. calignosa* (Sav.) are the most common in agricultural lands. There is even evidence that *A. calignosa* when fed with finely-ground plant litter can convert 6% of non-available nitrogen and excrete it in a form available to plants (Barley & Jennings, 1959).

Otanes & Sison (1947) list earthworms among the pests and recommend measures for their control. To those interested in their eradication or control one can mention the work of Hoy (1953) who has tried out some hydrocarbon insecticides on them. Likewise, Offer (1950) reports (regretfully perhaps) that a mixture of dichloropropane-dichloropropene applied to soils at 200-400 lb. per acre controls nematodes, centipedes, and wireworms but not earthworms. Baytop (1949) indicates that aquatic and alcoholic extracts of *Ammi visnaga* which is used as an anthelmintic in the Middle East is toxic to earthworms, the toxicity being due to Khellin content of the drug.

Resume

In a country as deficient in food and as dependent on agriculture as ours, it is indeed necessary to get better acquainted with the earthworm. By intensive cultivation, it is possible to have them in tremendous concentrations of over 2 million animals per acre. During the course of 24 hours, each worm can pass through its body its own weight of soil. Since a million worms weigh a ton one can calculate their potentialities for humus formation. Barrett (1955) maintains that it takes 500-1000 years to form one inch (2.5 cm.) of top soil and that under favourable conditions a ' task force ' of earthworms can do the same job in 5 years. Two points are, however, important. Firstly, intensive cultivation must primarily be achieved in culture boxes and then the cocoons and not the adults, are to be transferred to the field, because they have a much better chance of survival. Secondly, there should be sufficient raw material to support the added population. Amongst workers on these aspects are Guild (1951), Evans (1948), and others.

One cannot be too emphatic about their use in reclaiming eroded or flooded soil and in crop production, and it would certainly be feasible to consider them as auxiliary sources of food if more data could be gathered about their nutritional properties.

The first step to any scientific work is correct identification. Without proper identification of the species and, indeed, even the type, results may not always be repeatable. There are numerous differences between various forms, which only the expert can tell apart. To mention only a few, there are worms with and without a clitellum, calciferous glands, typhlosole, and endonephric nephridial systems. Again, the intestinal coeca may be present or absent, the prostate may vary in number and kind, and the spermatheca, testes, and seminal vescicles may likewise vary in many ways. Therefore, is it not logical to expect fundamental differences in the effects produced by them?

In India, research on this animal is handicapped by the fact that the survey of the *Oligochaeta* is in great need of revision since it was written in 1930 by Stephenson. Many changes have occurred in the taxonomic position of various types. Some have been merged with others and quite a few new species have been recognised. Gates has produced very valuable contributions to important genera like *Pheretima* and *Hoplochaetella* (1937-40) but much remains to be done by way of consolidating this knowledge and recording changes that have occurred since then. Almost certainly, one may expect the presence of peregrine forms in localities in which they were not recorded before. The many changes that have occurred in our newly developing country are doubtless going to affect the ecology, evolution, and exploitation of this animal, and it is rather sad that we have to meet this scientific challenge armed with an outdated Fauna.

In presenting this review, the authors would like to point out that much work has been omitted in order to keep it within the bounds required. The bibliography has also been curtailed to the barest minimum. The aim throughout has been to present a bird's-eye view of the various disciplines into which earthworm research has ramified. It is hoped that it will acquaint the specialist in one field with work in progress in other fields and thus enable him to achieve a better co-ordination in his efforts.

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Weeds and Alien Plants of Asirgarh, M.P.

BY

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INTRODUCTION

Asirgarh is a famous hill fort in Nimar District of Madhya Pradesh. It is situated at 21° 28′ N. and 76° 18′ E. and is about 29 miles from Khandwa and 7 miles from Chandni Station on the Central Railway. It is one of the oldest hill forts of India, as tradition mentions it in the Mahabharat. In the past the fort was an important stronghold in turn of the Chauhans, Moghuls, Marathas, and British. Till recently, it was held by a small detachment of Indian Infantry from Mhow. The hill, abounding in great natural and scenic beauty, is situated on an outlying spur of the Satpura Range, 850 ft. (260 m.) high from the base and 2283 ft. (696 m.) above sea-level.

In the literature one comes across casual references to Asirgarh (Hackel, 1889 ; Witt, 1916) but, to my knowledge, there had never been a systematic botanical exploration of the hill. Maheshwari (1960) gave a brief account of the forest vegetation of Asirgarh and reported 145 species of plants from the hill. The present work embodies the results of the studies of the author on the weeds and alien plants of Asirgarh. It is based on the collections of a number of botanical excursions undertaken during the years 1958 and 1959.

The study of weeds gains its importance because of their competition with the indigenes and cultigens on the terraces of the hill. It has been estimated in the U.S.A. that weeds alone cause more losses than all plant diseases and pests combined (Robbins *et al.*, 1953). In India, too, these losses are no less in importance or magnitude. However, in spite of the fact that these plants cause considerable damage in various ways, they are not absolutely useless and many advantages have been attributed to them. Most of these plants have great therapeutic properties and are used in medicine. It was, therefore, thought proper to make a systematic study of the weed and alien flora of the hill. The original home of the plants is indicated within brackets following the scientific names.[1]

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[1] The editors accept no responsibility for the author's opinions concerning the original country of the plants given in this paper.—EDS.

CLIMATIC CONDITIONS

Asirgarh is characterized by a dry, salubrious climate. Owing to its distance from the coast and because of the intervening mountain ranges, the hills receive considerably less rainfall than other parts of Madhya Pradesh. The cold weather lasts from the beginning of November to the middle of March. The hot winds usually begin about the middle of April and blow steadily from directions between north-west and west. Table below gives the climatic data on rainfall and temperature for the year 1956. The data on relative humidity were not available. However, from my own experience I can say that the area is characterized by low relative humidity.

TABLE

CLIMATOLOGICAL DATA OF ASIRGARH (1956)*

Month	Temperature in degrees C.			Rainfall in mm.
	Mean Maximum	Mean Minimum	Diurnal range	Monthly rainfall
January	29.7	12.9	16.8	—
February	32.2	13.2	19.0	—
March	37.5	18.9	18.6	—
April	40.2	23.8	16.4	—
May	40.9	27.7	13.2	—
June	34.7	25.3	9.4	256
July	29.3	23.1	6.2	77
August	29.8	22.7	7.1	477
September	31.5	22.8	8.7	102
October	32.8	19.4	13.4	—
November	28.9	14.8	14.1	152
December	29.4	11.1	18.3	—

*The data were supplied by the District Statistical Office, Nimar, M.P.

The average rainfall for the years 1940 to 1957 is 35.7 inches or 906.8 mm., of which about three-fourth falls between June and October. January is the coldest month of the year. The highest maximum temperature of 43.2°C. was recorded in the month of May, 1954. The scorching heat of this month and the hot winds make the weather during the day very trying. The diurnal range of temperature in Asirgarh is high, ranging between 13° and 19°C. during the relatively dry months of November to May ; the highest value occurring in February while the lowest value of 6° to 7° C. occurs during July and August.

General Aspects of the Weed and Alien Flora

This type of flora owes its presence in one way or other to certain changes brought about by man, such as the establishment of plantations and deforestation. These, coupled with intense grazing, have led to vast stretches of open lands on the hill, which are very susceptible to the invasion of an alien weed flora. The original forests have been cut down repeatedly, as a result of which a large portion of the hill is deprived of its primary vegetation ; instead a secondary succession of pantropical and cosmopolitan species of plants have gone into the composition of the flora. The original vegetation was further disturbed by a number of betel-vine gardens and several acres of vineyards formerly existed on the hill (Imperial Gazetteer of India, 1908).

A perusal of the weed species reveals that the majority of them come from the pantropical region and India orientalis, and belong to the dicotyledonous families. Being aggressive in nature, having very viable seeds which are produced in great abundance and are well equipped for dissemination by wind, man, and animals, these plants quickly spread under cultural operations and exhaust the soil nutrients, thereby affecting forest yield. The families Amaranthaceae, Papilionaceae, Euphorbiaceae, Malvaceae, Compositae, and Gramineae, are notably rich in weeds. The important phyto-geographical groups represented in the flora are : pantropical, neotropical, tropics of the Old World, cosmopolitan, India orientalis, tropical Asia, Africa, and Australia. Typical examples of weeds representing the neotropical region are: *Argemone mexicana* L., *Sida veronicifolia* Lam., *Tridax procumbens* L., *Nicotiana plumbaginifolia* Viv., *Datura metel* L., *Tecoma stans* H.B. & K., *Lantana camara* var. *aculeata* Mold., *Euphorbia prostrata* Ait., *Digitaria adscendens* Henr., *Chloris virgata* Sw., and *Iseilema laxum* Hack.

Among the rainy season weeds and alien plants occurring on the slopes of the hill as well as in waste places, the following deserve mention :

Celosia argentea Linn.
Leucas cephalotes Spreng.
Phyllanthus fraternus Webst.
Acalypha indica Linn.
Abelmoschus moschatus Medic.
A. ficulneus W. & A.
Abrus precatorius Linn.
Teramnus labialis Spreng.
Mucuna prurita Hook.
Justicia simplex D. Don.
Cyperus triceps Endl.
Aristida depressa Retz.

Trichodesma indicum R. Br.
Triumfetta bartramia Linn.
Crotalaria medicaginea var. *luxurians* Baker
Indigofera astragalina DC.
Rhynchosia minima DC.
Tephrosia villosa Pers.
T. strigosa Sant. & Mahesh.
Tetrapogon tenellus Chiov.
Setaria verticillata Beauv.
S. tomentosa Kunth.
Digitaria adscendens Henr.
Brachiaria ramosa Stapf.
Hackelochloa granularis Kuntze
Ischaemum pilosum Hack.
Themeda quadrivalvis Kuntze
Oropetium thomaeum Trin.

The following are the common winter weeds found on the hill :

Oxalis corniculata Linn.
Ageratum conyzoides Linn.
Laggera flava Benth.
Sonchus arvensis Linn.
S. asper Hill.
Vicoa indica DC.
Pulicaria angustifolia DC.
Eriophorum comosum Wall.
Cymbopogon martinii Wats.
Heteropogon contortus R. & S.
Eremopogon tuberculatus Camus

Inhabiting the old, semi-demolished walls of the fort, one comes across a characteristic association of lithophilous plants. The common species of this peculiar habitat are :

Kickxia incana Penn.
Eriophorum comosum Wall.
Eremopogon tuberculatus Camus
Boerhavia diffusa Linn.
Tridax procumbens Linn.
Enicostemma verticillatum Engl.
Andrographis echioides Nees.
Peristrophe bicalyculata Nees.
Euphorbia prostrata Ait.
Acalypha indica Linn.
Acalypha sp.
Nepeta hindostana Haines

ENUMERATION OF SPECIES

MENISPERMACEAE

1. **Cissampelos pareira** Linn. (Tropics). Common on shrubs and trees. Fls. and Frs.: July-Oct.

2. **Cocculus hirsutus** Diels. (India orientalis, Tropical Africa). Common on trees and shrubs, or spreading on the ground. A fodder plant in times of scarcity. Fls. and Frs.: Nov.-March.

PAPAVERACEAE

3. **Argemone mexicana** Linn. (Neotropical). Rare on the hill itself; fairly common at the foot of the hill. A poisonous and troublesome weed. Fls. and Frs.: Oct.-April.

CRUCIFERAE

4. **Rorippa indica** Hochreut. (India orientalis, China, Malaya). Found in moist situations on the slopes. Fls. and Frs.: Dec.-July.

CAPPARIDACEAE

5. **Gynandropsis gynandra** Briq. (Tropics). A weed of waste lands and cultivated fields, at the base of the hill. Fls. and Frs. : July-Sept.

6. **Cleome viscosa** Linn. (Tropics of the Old World). Common in fields and ruderal places at the foot of the hill. Fls. and Frs. : July-Oct.

7. **Cleome monophylla** Linn. (India orientalis, Tropical Africa). A weed of pastures and cultivated lands at the very base of the hill; not seen on Asirgarh proper. Fls. and Frs. : Aug.-Oct.

CARYOPHYLLACEAE

8. **Polycarpaea corymbosa** Lam. (Tropics). Found in cultivated fields at the foot of the hill. Fls. and Frs. : Aug.-Nov.

MALVACEAE

9. **Sida veronicifolia** Lam. (Neotropical). Found in the undergrowth on the hill. Fls. and Frs. : June-Oct.

10. **Abutilon indicum** Sweet. (Old World). Found in the undergrowth on the higher parts of the hill. Fls. and Frs. : Major part of the year.

11. **Abutilon ramosum** G. & P. (Tropics of the Old World). Rare in the undergrowth on the slopes. Fls. and Frs. : Oct.-Feb.

12. **Malvastrum coromandelianum** Garcke. (Tropics). Common all over Asirgarh. Fls. and Frs. : Major part of the year.

13. **Hibiscus micranthus** Linn. f. (India orientalis et Tropical Africa). Common all over the hill. Fls. and Frs. : July-Oct.

14. **Abelmoschus ficulneus** W. & A. (Tropics of the Old World). Common on the top of the hill. Fls. and Frs. : Aug.-Oct.

15. **Abelmoschus moschatus** Medic. (Tropics of the Old World). Common in waste lands on the top of the hill. Fls. and Frs. : Aug.-Oct.

TILIACEAE

16. **Triumfetta bartramia** Linn. (Tropics). Common in waste lands on the hill. Fls. and Frs. : Aug.-Dec.

ZYGOPHYLLACEAE

17. **Tribulus terrestris** Linn. (Tropics). A weed of waste lands. Fls. and Frs. : July-Dec.

OXALIDACEAE

18. **Oxalis corniculata** Linn. (Tropics and Temperates). Common in moist, shady situations on the slopes. Fls. and Frs. : Nov.-June.

AMPELIDACEAE

19. **Cayratia carnosa** Gagnep. (Tropical Asia et Australia). Common on trees and shrubs. Fls. and Frs.: Rainy season.

20. **Cissus repanda** Vahl. (India orientalis). Common on trees and shrubs along the slopes. Fls. and Frs.: May-Oct.

SAPINDACEAE

21. **Cardiospermum halicacabum** Linn. (Tropics). Common in waste lands on the higher parts of the hill. Fls. and Frs.: Aug.-Nov.

PAPILIONACEAE

22. **Crotalaria medicaginea** var. **luxurians** Baker. (Tropical Asia et Australia). Common along the paths and in grass fields on the slopes. Fls. and Frs.: July-Nov.

23. **Crotalaria orixensis** Willd. (India orientalis et Tropical Africa). A weed in cultivated fields at the foot of the hill. Fls. and Frs.: Aug.-Oct.

24. **Indigofera astragalina** DC. (Tropics of the Old World). Common in waste places on the top of the hill. Fls. and Frs.: Sept.-Nov.

25. **Indigofera enneaphylla** Linn. (Tropical Asia et Australia). Common in grass fields. Fls. and Frs.: Summer and rainy seasons.

26. **Indigofera cordifolia** Heyne ex Roth. (Tropics of the Old World). Common in open grasslands all over the hill. Fls. and Frs.: Rainy season.

27. **Indigofera linifolia** Retz. (Tropics of the Old World). Common in Asirgarh in grass fields. Fls. and Frs.: Rainy season.

28. **Indigofera argentea** var. **coerulea** Baker. (India). Rare in waste lands at the foot of the hill. Fls. and Frs.: Sept.-Jan.

29. **Psoralea corylifolia** Linn. (India orientalis et Arabia). A weed of cultivated fields at the foot of the hill. Fls. and Frs.: Feb.-April.

30. **Tephrosia strigosa** Sant. & Mahesh. in *J. Bombay nat. Hist. Soc.* **54**: 804, 1957. (India orientalis). Common in open grasslands all over the hill. Fls. and Frs.: Aug.-Oct.

31. **Tephrosia villosa** Pers. (Tropical Asia et Africa). Found in dry waste lands on the hill. Fls. and Frs.: Rainy season.

32. **Tephrosia purpurea** Pers. (Tropics). Common all over Asirgarh. Fls. and Frs.: June-Nov.

33. **Abrus precatorius** Linn. (Tropics). Found on trees and shrubs on the slopes. Fls. and Frs.: Aug.-Oct.

34. **Teramnus labialis** Spreng. (Tropics). Common on trees and shrubs on the slopes, or spreading on the ground. Fls. and Frs.: Aug.-Nov.

35. **Mucuna prurita** Hook. (Tropics). Common all over the slopes, twining on trees and shrubs. The bristly pods cause an intense skin irritation which continues for hours. Fls. and Frs.: Rainy season.

36. **Rhynchosia minima** DC. (Tropics). Found on the walls of the fort, or twining on dead bushes. Fls. and Frs.: Aug.-Nov.

37. **Atylosia platycarpa** Benth. (Himalayan Region). A weed of waste lands at the foot of the hill. Fls. and Frs.: Sept.-Dec.

38. **Alysicarpus pubescens** Law. (India orientalis). An occasional weed in grass fields on the hill. Fls. and Frs.: Aug.-Oct.

39. **Heylandia latebrosa** DC. (India orientalis). Common on the plains at the foot of the hill; rare above. Fls. and Frs.: Aug.-Oct.

CAESALPINIACEAE

40. **Cassia tora** Linn. (Pantropical). Common at the foot of the hill and along the road to Khandwa, Burhanpur and Nepanagar. Fls. and Frs.: Aug.-Nov.

41. **Cassia occidentalis** Linn. (Pantropical). Not seen on the hill; common at the foot of the hill and along the road to Khandwa, Burhanpur, and Nepanagar. Fls. and Frs.: Aug.-Nov.

CUCURBITACEAE

42. **Coccinia cordifolia** Cogn. (Tropical Asia). Common all over the hill on trees and shrubs. Fls. and Frs.: March-Oct.

43. **Bryonopsis laciniosa** Naud. (Tropical Asia, Africa, et Australia). Common all over Asirgarh, on shrubs and trees. Fls. and Frs.: Aug.-Oct.

LYTHRACEAE

44. **Woodfordia fruticosa** Kurz. (Tropical Asia et Africa). Common in rocky places on the hill, often growing out of old stone walls. Fls. and Frs.: Jan.-May.

CACTACEAE

45. **Opuntia dillenii** Haw. (Neotropical). A weed on the plains at the base of the hill; rare above. Fls. and Frs.: March-May.

AIZOACEAE

46. **Trianthema portulacastrum** Linn. (Neotropical). A weed of cultivation, at the foot of the hill. Fls. and Frs.: July-Dec.

47. **Trianthema govindia** Buch.-Ham. ex G. Don. (India, Persia et Arabia). Common in dry waste lands at the base of the hill. Fls. and Frs.: July-Oct.

RUBIACEAE

48. **Borreria stricta** Sch. (Tropics of the Old World). A common weed in the forest undergrowth. Fls. and Frs.: Aug.-Dec.

49. **Oldenlandia corymbosa** Linn. (Tropics). Common on the plains at the foot of the hill. Fls. and Frs.: Sept.-Nov.

50. **Hamiltonia suaveolens** Roxb. (India orientalis et China). Common in dry places on the upper parts of the hill. Fls. and Frs.: Nov.-March.

COMPOSITAE

51. **Launaea nudicaulis** Hook. f. (India orientalis). Common all over Asirgarh. Fls. and Frs.: Sept.-March.

52. **Sonchus arvensis** Linn. (Europe et Asia). Found in waste lands on the higher parts of the hill. Fls. and Frs.: Dec.-March.

53. **Sonchus asper** Hill. (Cosmopolitan). Common in waste lands on the hill. Fls. and Frs.: Cold season.

54. **Vernonia cinerea** Less. (Tropics). Common in waste lands and along the paths. Fls. and Frs.: Rainy and cold seasons.

55. **Ageratum conyzoides** Linn. (Tropics). Found in moist situations on the slopes. Fls. and Frs.: Oct.-June.

56. **Vicoa indica** DC. (India orientalis et Burma). Common on the slopes of the hill. Fls. and Frs.: Oct.-March.

57. **Pulicaria angustifolia** DC. (India orientalis). It grows on open slopes. Fls. and Frs.: Oct.-Feb.

58. **Blumea obliqua** var. **arenaria** Mahesh. in *J. Bombay nat. Hist. Soc.* **54**: 805, 1957. (India orientalis). Common on the higher parts of the hill. Fls. and Frs.: Feb.-May.

59. **Laggera flava** Benth. (Tropical Asia). Common in dry waste lands on the higher parts of the hill. Fls. and Frs.: Jan.-April.

60. **Xanthium strumarium** Linn. (Europe, Asia et Africa). A bad weed of dried up marshes and waste lands at the foot of the hill; rare above. Fls. and Frs.: Sept.-Nov.; April.

61. **Tridax procumbens** Linn. (Neotropical). Common all over Asirgarh as well as on the walls of the fort. Fls. and Frs.: Dec.-May.

62. **Echinops echinatus** Roxb. (India orientalis). Common in dry waste lands and grass fields on the upper parts of the hill. Fls. and Frs.: Jan.-June.

63. **Lagascea mollis** Cav. (Cuba). A weed of waste lands on the higher parts of the hill. Fls. and Frs.: May-Dec.

64. **Glossocardia bosvallea** DC. (India orientalis). Common in rocky grounds. Fls. and Frs.: Aug.-Oct.

65. **Acanthospermum hispidum** DC. (Neotropical). An obnoxious weed of waste lands and fallow fields at the foot of the hill. Fls. and Frs.: July-Dec.

GENTIANACEAE

66. **Enicostemma verticillatum** Engl. (Tropics). Common at the top of the hill, in the crevices of stairs leading to Juma Masjid. Fls. and Frs.: Sept.-March.

ASCLEPIADACEAE

67. **Calotropis gigantea** R. Br. (India orientalis). Found at the foot of the hill; not seen on Asirgarh proper. Fls. and Frs.: Nov.-March.

68. **Pergularia daemia** Blatt. & McC. (India orientalis, Tropical Africa, et Malaya). Common on shrubs or trees. Fls. and Frs.: Aug.-Jan.

69. **Hemidesmus indicus** R. Br. (Ceylon). A weed in 'Jowar' fields at the foot of the hill. Fls. and Frs.: Sept.-Dec.

CONVOLVULACEAE

70. **Ipomoea pes-tigridis** Linn. (Tropics of the Old World). A weed in fields at the foot of the hill. Fls. and Frs.: Sept.-Oct.

71. **Ipomoea nil** Roth. (Circumtropical). Common on Asirgarh. Fls. and Frs.: Aug.-Oct.

72. **Ipomoea eriocarpa** R. Br. (Tropics of the Old World). A common weed in fields of 'Jowar.' Fls. and Frs.: Sept.-Oct.

73. **Evolvulus alsinoides** Linn. (Tropics). Common in open grasslands all over the hill. Fls. and Frs.: July-Nov.

74. **Convolvulus arvensis** Linn. (Temperates of the Old World). A poisonous pest among crops grown at the base of the hill. Fls. and Frs.: July-Dec.

75. **Convolvulus pluricaulis** Choisy. (India orientalis). Common in rocky ground. Fls. and Frs.: Major part of the year.

BORAGINACEAE

76. **Trichodesma indicum** R. Br. (India orientalis, Afghanistan, et Persia). Common on the higher parts of the hill. Fls. and Frs.: After rains.

77. **Heliotropium strigosum** Willd. (Tropical Africa, Baluchistan, et Australia). Common all over Asirgarh. Fls. and Frs.: During and after rains.

78. **Heliotropium eichwaldi** Steud. ex DC. (Europe, Asia, et Australia). Not seen on the hill of Asirgarh proper; it is found in dry waste lands at the base of the hill. Fls. and Frs.: March-July.

SOLANACEAE

79. **Nicotiana plumbaginifolia** Viv. (Neotropical). Found in the undergrowth on the higher parts of the slopes. Fls. and Frs.: April-June.

80. **Datura metel** Linn. (Neotropical). Found here and there, all over the hill. Fls. and Frs.: Nov.-Jan.

81. **Solanum nigrum** Linn. (Pantropical). Found in dry waste lands or on the walls of the fort. Fls. and Frs.: Cold and summer seasons.

82. **Solanum suratense** Burm f. (Tropics of the Old World). A weed in cultivated grounds at the foot of the hill. Fls. and Frs.: June-Sept.

BIGNONIACEAE

83. **Tecoma stans** H.B. & K. (Neotropical). Naturalized on the slopes of the hill. Fls. and Frs.: July-April.

SCROPHULARIACEAE

84. **Kickxia incana** Penn. (Himalayan Region). Lithophyte; common on the walls of the upper parts of the fort. Fls. and Frs.: Cold season.

85. **Striga densiflora** Benth. (India orientalis). A harmful weed of cultivated fields at the base of the hill. Fls. and Frs.: Aug.-Oct.

MARTYNIACEAE

86. **Martynia annua** Linn. (Neotropical). Not seen on the hill; found in waste lands at the foot of the hill. Fls. and Frs.: Aug.-Oct.

ACANTHACEAE

87. **Andrographis echioides** Nees. (India orientalis). Common in the crevices of fort walls and stairs leading to Juma Masjid. Fls. and Frs.: Nov.-March.

88. **Peristrophe bicalyculata** Nees. (Tropical Asia et Africa). Grows in the undergrowth all over the hill, or in the crevices of fort walls. Fls. and Frs.: Sept.-Dec.

89. **Justicia simplex** D. Don. (Tropical Asia et Africa). Common all over the hill. Fls. and Frs.: Aug.-Dec.

90. **Barleria prionitis** Linn. (Tropical Asia et Africa). It is found in waste lands on the higher parts of the hill. Fls. and Frs.: Oct.-March.

91. **Lepidagathis cristata** Willd. (India orientalis). Common throughout in dry waste lands. Fls. and Frs.: Oct.-April.

VERBENACEAE

92. **Lantana camara** var. **aculeata** Mold. (Neotropical). A very troublesome pest; scattered in secondary forests on Asirgarh slopes. Fls. and Frs.: Major part of the year.

93. **Clerodendrum phlomidis** Linn. f. (India orientalis). Common on the slopes of the hill. Fls. and Frs.: Aug.-Nov.

LABIATAE

94. **Nepeta hindostana** Haines. (Europe et Oriens). Grows in cool, shady situations on the slopes, or on the walls of the fort. Fls. and Frs.: Jan.-Aug.

95. **Leucas cephalotes** Spreng. (India orientalis). Common on the hill. Fls. and Frs.: Aug.-Oct.

96. **Lavandula bipinnata** O. Kuntze. (India orientalis). Common in dry waste lands on the upper parts of the hill. Fls. and Frs.: Oct.-Feb.

97. **Ocimum americanum** Linn. (Tropical Asia et Africa). Common in rocky grounds. Fls. and Frs.: July-Nov.

98. **Ocimum** sp. An aromatic herb, with inflorescence *c.* 30 cm. long. It grows on the upper parts of the hill. Fls. and Frs.: Cold season.

NYCTAGINACEAE

99. **Boerhavia diffusa** Linn. (Pantropical). Common all over the hill and on the walls of the fort. Fls. and Frs.: Major part of the year.

AMARANTHACEAE

100. **Aerva lanata** Juss. (Tropical Asia et Arabia). Common in shady situations on the slopes. Fls. and Frs.: After rains.

101. **Celosia argentea** Linn. (Pantropical). A weed in grass fields on the hill Fls. and Frs.: Aug.-Oct.

102. **Amaranthus spinosus** Linn. (Tropics). Fairly common at the foot of the hill; not seen on Asirgarh proper. Fls. and Frs.: During and after rains.

103. **Amaranthus gracilis** Desf. (Tropics). A weed of cultivated fields and waste places; rare on the hill. Fls. and Frs.: After rains.

104. **Achyranthes aspera** var. **porphyristachya** Hook. f. (Tropics of the Old World). Common all over the hill. Fls. and Frs.: Throughout the year.

105. **Pupalia lappacea** Juss. (Tropical Asia et Africa). Common here and there on the hill. Fls. and Frs.: After rains.

106. **Digera alternifolia** Aschers. ap. Schweinf. (Tropical Asia et Africa). A weed of cultivated fields at the foot of the hill. Fls. and Frs.: During and after rains.

EUPHORBIACEAE

107. **Tragia hildebrandtii** Muell.-Arg. in Bremen, Abh. 7 : 26, 1880; Cufodontis in Bull. Jard. Bot. Brux. Suppl. 26 (fasc. 3) : 427, 1956.
Tragia cannabina Linn. f. Suppl. 415, 1781, *nom. illeg.*
Tragia involucrata Linn. var. *cannabina* Muell.-Arg. in DC. Prod. 15 : 944, 1866; Hook. f. in Fl. Brit. Ind. 5 : 465, 1888.

A weed of cultivated and waste lands at the foot of the hill; not seen high on the hill. The stinging hairs cause an intense skin irritation which continues for hours. Fls. and Frs.: Summer and rainy seasons.

TYPE: Hildebrandt 2041 (Mombassa).

DISTRIB: Madhya Pradesh (Nimar, Gwalior), Bombay State, peninsular India; Tropical Africa.

108. **Euphorbia hypericifolia** Linn. (Tropics). Grows in grass fields. Fls. and Frs.: July-Oct.

109. **Euphorbia hirta** Linn. (Tropics). Common all over the hill. Fls. and Frs.: Major part of the year.

110. **Euphorbia prostrata** Ait. (Neotropical). Common in rocky grounds, or on the walls of the fort. Fls. and Frs.: Major part of the year.

111. **Euphorbia geniculata** Orteg. (Neotropical). A weed of gardens and cultivated lands at the foot of the hill; rare above. Fls. and Frs.: May-Dec.

112. **Acalypha indica** Linn. (Tropical Asia et Africa). Found in the undergrowth on the slopes, or on the walls of the fort. Fls. and Frs.: July-Oct.

113. **Acalypha** sp. Common in shady situations on the slopes and in the crevices of walls. Fls. and Frs.: Aug.-Feb.

114. **Chrozophora prostrata** Dalz. (Europe, Asia, et Africa). Common in dried up ditches and canals at the foot of the hill. Fls. and Frs.: May-June.

115. **Chrozophora rottleri** Klotzsch. (Europe, Asia, et Africa). A weed of black cotton soils, dry places, and canal beds at the foot of the hill. Fls. and Frs. : April-July.

116. **Phyllanthus fraternus** Webst. (India). Common in the undergrowth on the higher parts of the hill. Fls. and Frs.: July-Oct.

LILIACEAE

117. **Scilla indica** Baker. (India orientalis et Abyssinia). A common weed of pastures and waste lands at the foot of the hill; rare above. Fls. and Frs.: March-May.

118. **Asphodelus tenuifolius** Cav. (India orientalis). Common in cultivated fields at the base of the hill. Fls. and Frs.: Jan.-April.

COMMELINACEAE

119. **Commelina benghalensis** Linn. (Tropics of the Old World). Found in fields at the foot of the hill. Fls. and Frs.: July-Nov.

120. **Cyanotis axillaris** Schult. f. (India orientalis). Fairly common in some parts of the hill. Fls. and Frs.: Oct.-Dec.

121. **Cyanotis fasciculata** R. & S. (India orientalis). Common in rocky ground. Fls. and Frs.: Rainy season.

CYPERACEAE

122. **Cyperus triceps** Endl. (Tropics of the Old World). Common all over the hill. Fls. and Frs.: July-Nov.

123. **Cyperus rotundus** Linn. (Cosmopolitan). Common all over the hill. Fls. and Frs.: July-Oct.

124. **Eriophorum comosum** Wall. ex Nees. (India orientalis). Common on the walls of the fort. Fls. and Frs.: Oct.-Feb.

GRAMINEAE

125. **Iseilema laxum** Hack. (Neotropical). Common in open grasslands all over the hill. An efficient soil binder and an excellent fodder. Fls. and Frs.: Sept.-Dec.

126. **Eremopogon tuberculatus** Camus. (Madhya Pradesh, India). This grass seems to be endemic in Madhya Pradesh (*see* Raizada et Jain, in *J. Bombay nat. Hist. Soc.* **54**: 860, 1957). Hackel (in DC. Monograph. Phan. 6 : 404, 1889) writes of this grass: 'In Indiae orient. Peninsula pr. Assirgar legit. cl. O. Kuntze hanc speciem eximiam (Vidi in ipsius herb.).'

I have found it growing commonly on the walls of the fort of Asirgarh. Fls. and Frs.: Oct.-Feb.

127. **Tetrapogon tenellus** Chiov. (India orientalis). Common in rocky ground all over the hill. Fls. and Frs.: July-Oct.

128. **Melanocenchrus jacquemontii** Jaub. et Spach. (India orientalis). Very common on rocky surfaces and shallow poor soils all over the hill. Fls. and Frs.: July-Oct.

129. **Setaria verticillata** Beauv. (Cosmopolitan). Common in the undergrowth on the slopes. Fls. and Frs.: During and after rains.

130. **Setaria tomentosa** Kunth. (India orientalis). Common all over the hill. Fls. and Frs.: Aug.-Feb.

131. **Tragus biflorus** Schult. (Mediterranean Region et Afghanistan). Common in rocky grounds and dry waste lands on the hill. Fls. and Frs.: July-Oct.

132. **Eragrostis cilianensis** Link ex Lutati. (Tropics). Found in cultivated fields at the base of the hill. Fls. and Frs.: May-Oct.

133. **Eragrostis tremula** Hochst. (Tropics of the Old World). Fallow and cultivated fields at the foot of the hill. Fls. and Frs.: Aug.-Nov.

134. **Eragrostis pilosa** Beauv. (Warmer parts of the World). Common on sandy, gravelly soils and on old walls. Fls. and Frs.: June-Nov.

135. **Alloteropsis cimicina** Stapf. (India orientalis). A fair fodder grass in waste lands. Fls. and Frs.: July-Sept.

136. **Chloris virgata** Sw. (Neotropical). Common on the upper parts of the hill. Fls. and Frs.: July-Oct.

137. **Chloris barbata** Sw. (Tropics). A good fodder. Fls. and Frs.: Aug.-Oct.

138. **Digitaria royleana** Prain. (Tropical Asia). Common in waste places. Fls. and Frs.: July-Oct.

139. **Digitaria adscendens** Henr. (Neotropical). Common all over the hill. Fls. and Frs.: July-Oct.

140. **Digitaria setigera** Roth apud R. & S. (Cosmopolitan). A common weed of waste places. Fls. and Frs.: July-Oct.

141. **Cynodon dactylon** Pers. (Cosmopolitan). Common all over the hill. As fodder is much relished by cattle. Fls. and Frs.: Major part of the year.

142. **Oplismenus burmannii** Beauv. (Tropics). Common in the undergrowth on the hill. Fls. and Frs.: June-Dec.

143. **Bothriochloa pertusa** A. Camus. (Tropical Asia, Africa, et Australia). A good fodder grass; seen all over the hill. Fls. and Frs.: July-Oct.

144. **Bothriochloa kuntzeana** Henr. (India orientalis). Hackel (in DC. Monograph. Phan. 6 : 478, 1889) writes of this plant: 'Pennis. Indiae orientalis, in prov. Centr. prope Assirgar (Kuntze in h. prop.)' I have not seen the plant in the district.

145. **Dichanthium annulatum** Stapf. (India orientalis et Australia). Common all over the hill. Fls. and Frs.: Cold and summer seasons.

146. **Brachiaria ramosa** Stapf. (India orientalis). It is a good fodder grass. Common all over the hill. Fls. and Frs.: June-Oct.

147. **Brachiaria eruciformis** Griseb. (Mediterranean Region et India orientalis). A common weed of 'Jowar' fields at the foot of the hill. Much eaten by animals. Fls. and Frs.: Sept.-Nov.

148. **Aristida depressa** Retz. Linn. (Temperates et warmer parts). One of the earliest grasses. An obnoxious weed, all over the hill. Fls. and Frs.: July-Oct.

149. **Aristida funiculata** Trin. (North Africa, Arabia, et Baluchistan). An obnoxious weed in shallow poor soils on the hill; the awns pierce through clothes. Fls. and Frs.: July-Oct.

150. **Sorghum halepense** Pers. (Europe, Asia, et Africa). A pest in cultivated grounds, but a useful fodder grass in permanent pastures. Found in the crevices of exposed rocks on the hill. Fls. and Frs.: Sept.-Feb.

151. **Sorghum deccanense** Stapf. (Abyssinia). Found here and there on the hill. Fls. and Frs.: After rains.

152. **Chrysopogon fulvus** Chiov. (India orientalis). A drought-resistant grass; common all over the hill. Fls. and Frs.: During and after rains.

153. **Hackelochloa granularis** Kuntze. (Tropics). Common in grass fields on the hill. Fls. and Frs.: Aug.-Oct.

154. **Heteropogon contortus** R. & S. (Tropics). A very troublesome weed, all over the hill. Fls. and Frs.: Oct.-Dec.

155. **Ischaemum pilosum** Hack. (Ceylon). Common on the hill as well as in black cotton soils at the base of the hill. Also recorded by Hackel (loc. cit.: 241) on the authority of Dr. Otto Kuntze, who collected the grass from this area. Fls. and Frs.: Aug.-Oct.

156. **Ischaemum laxum** Br. (Tropics of the Old World). A common weed on black soils. Fls. and Frs.: Aug.-Oct.

157. **Andropogon pumilus** Roxb. (India orientalis). Hackel (loc. cit. 450) writes of this grass: ' Peninsula Indiae Orient. (Wight 1701); in prov. Centr. pr. Assirgar (Kuntze in h. prop.), Tschanda (Duthie mis.), ...'. Not seen by me in the vicinity of Asirgarh. However, it grows commonly on Khandwa plateau and is easily recognized by its copper-coloured appearance.

158. **Cymbopogon martinii** Wats. (Tropical Asia et Africa). Common on the slopes of the hill. It yields the commercial Rusa grass oil. Fls. and Frs.: Oct.-Feb.

159. **Themeda quadrivalvis** Kuntze. (India orientalis et Africa). Common in grass fields on the higher parts of the hill. Fls. and Frs.: Sept.-Dec.

160. **Arthraxon ciliaris** Beauv. (Tropical Asia, Africa et Australia). A common weed under the shade of trees. Fls. and Frs.: After rains.

161. **Oropetium thomaeum** Trin. (India orientalis). One of the earliest grasses to appear and disappear; common on rock surfaces and shallow soils on the hill. Fls. and Frs.: Rainy season.

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Quail Breeding in Japan[1]

BY

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(*With two plates and one text-photo*)

INTRODUCTION

Several species of wild birds have been domesticated in Japan, such as Java Sparrow, Sharptailed Munia (=Bengalee), Zebra Finch, etc. They are not only popular as pets, but also exported in great numbers to foreign countries. However, the Japanese Quail (*Coturnix coturnix japonicus* Temminck) is the only one which was domesticated for the sake of its meat and eggs.

HISTORY

The Japanese Quail was originally domesticated as a good songbird. The practice is said to have originated during the Muromachi Era about 600 years ago, and there remain some accurate records made after the Keichō Period (1596 A.D.) on raising domesticated quails. The raising of song quails was most vigorous during the Meiwa to An-ei Period (1764-1780 A.D.), and it was continued with vicissitudes until World War II. White varieties were developed among these song quails. However, the song quails were swept out of existence from Japan during World War II, and only the beautiful and luxurious tools, cages, etc., now remain to remind us of their former popularity.

The domesticated quail as a table delicacy, which I am going to describe in this article, has been selected from the abovementioned song quails. It is said that in about 1910 Mr. Kotarō Oda selected good laying quails from among his several thousand domesticated quails, and bred them to the present variety, so that we can trace back the history of the quail domesticated as a delicacy to no more than just 50 years.

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[1] Communicated by Dr. Sálim Ali.

The producers of domesticated quails for eggs and meat increased since then. They were concentrated specially in Aichi Prefecture, the centre of Japan proper, and this prefecture became highlighted as the headquarters of the industry. During the period 1937-38, just before World War II, the number of domesticated quails for delicacies in this prefecture alone was estimated at as much as 350,000. However, the great war which swept the song quails out of Japan also inflicted a severe loss on the domesticated quails for delicacies and almost exterminated them. Fortunately, some of these domesticated quails remained with Mr. Kawashima who lived in Urawa City of Saitama Prefecture, the northern suburbs of Tokyo; and later, Mr. Keiji Suzuki of Toyohashi City, Aichi Prefecture, took these over, bred and multiplied them, and laid the foundation for the present prosperity of the quail-raising industry.

Regarding the raising of the Japanese domesticated quails, Dr. N. Takatsukasa made a brief report in 1921; however, the raising technique he described is rather outdated. Quail raising could hardly be called an 'industry' at that time, so I think it is necessary to describe the modern methods.

Present day foreign travellers to Japan often find eggs of small birds on the table, and are shocked at the seeming persistence in this country of the bad custom of eating the commercialized eggs of wild birds. These eggs, however, are not of wild birds, but of the domesticated quails which I am going to describe in the following pages.

1. HATCHING

In recent years, the annual production of domesticated quails in Japan is 1,000,000 to 2,000,000 with some fluctuation from year to year. The great majority of the above quails are incubated by electric incubators in three hatcheries in Toyohashi City. The largest hatchery is the Suzuki Hatchery, where 35,000 breeding quails are always kept, and the eggs produced there are shipped out to all the districts of Japan.

The incubation period is 16 or 17 days. The sexing of day-old chicks at hatching time is made by special technicians by the examination of the rudimentary copulatory organs, popularly known as the Japanese method of sexing chicks. Only female chicks are delivered to the customers. The packing boxes of day-old chicks shown in Photo 1 are made of paper board and divided into four sections. One hundred day-old chicks are packed in each box.

Except in the winter period, this box is available for within four days' transport. Some male chicks are retained and raised for meat like domestic fowl; the rest are disposed of.

2. RAISING OF CHICKS

The day-old chicks delivered from a hatchery are fed in a brooding box with a heater for one week (Photo 2). The brooding box consists of 12 small sections, sized 90 cm. × 60 cm., and one-third of each small section is covered with a roof and heated by a hot water pipe. The total number of chicks reared in the twelve sections is about 2000.

After one week in the brooding box, the chicks are transferred to cages (or batteries) without heater (Photo 3). Thirty-six cages, each sized 30 cm. wide, 60 cm. deep, 7.5 cm. high, are piled up. The total number of chicks reared in these 36 cages is 1800. These cages (or batteries) are not connected with a heater. Even in cold weather, it is sufficient if the room containing these cages is heated up a little. Quail chicks are fed in these cages for 6 days, and then transferred to 'adult' cages, each of size 30 cm. × 90 cm., and divided into three sections. The density of young hens held here is slightly higher than in the case of adult layers: 20 young hens three weeks old per the space of 30 cm. × 30 cm., or 15 four weeks old. In the fifth week, the quails are transferred into the laying cages (or batteries).

The diet for brooding or raising quail chicks is similar to that of chicken chicks. But the powdered food should be finer since the quail chicks are so much smaller. Usually the diet is given as mashed food, mixed dry powder and water. Recently, some people are using dry powder food and showing good results.

Since the time when given their first feed the chicks are continuously lighted day and night by electric bulbs. As mentioned later, the domesticated quails are also lighted throughout the egg-laying period. Thus they pass their whole life under artificial light.

3. RAISING OF LAYING QUAILS

At 30 days old, young quails become as large as adults and ready to breed, and they are then transferred into the laying room. They lay the first egg when 35-60 days old, usually when 50 days old. During 8-12 months from that time they keep on laying eggs. The laying efficiency for the first year is 80%, so that the number of eggs laid in the first year runs to between 250 and 300. They are by no means inferior in laying efficiency to the best performance of the domestic fowl.

Quail raising recently has a tendency to be on a large scale. A man who specializes in raising domesticated quails usually possesses more than 10,000 birds. Photo 4 shows a typical laying house which consists of five rooms for laying quails and one room for food supply, with a passage along the windows of the south side of the house. As shown in Photo 5, quail cages are arranged along both sides of the laying room of which the capacity is 2000 quails.

The laying cage unit (Photo 6) measures 90 cm.×30 cm.×10 cm. The bottom is a sloping wire screen higher behind, lower in front. The quails live on the screen floor and stretch out their heads through a running gap or slit to feed from a hopper which is installed on the front side of the cage. The tilt of the wire screen is very useful for collecting eggs, because the eggs roll down the slope into the front side of the cage (Photo 7). The birds' droppings fall through the screen on to the droppings-board under the cage.

The important points in promoting laying ability are as follows:

1. The food is a mixture of the following components:

Fish meal (including no salt)	30%
Corn-flour	25%
Wheat bran	15%
Rice bran	27%
Powder of dried grass leaves	3%

The above ratios of food components vary somewhat with individual poultrymen, but the quail food should include more protein ingredients than in the case of domestic fowl. When soft food (or moist paste)—a mixture of triturated food and water—is given, no more water or greens are necessary. Of course if dry food is given, water should be provided separately.

2. The laying room is lighted day and night. Photo 8 shows a sample of laying room, which is lighted day and night by a fluorescent bulb of 6 watts per six sq. metres. To sleep, the quails retire to the inner and dusky part of the cage.

3. The density of quails in a cage has an influence upon their laying efficiency. Too high a density produces unsatisfactory results, likewise too low density reduces the laying efficiency. The optimum density is considered to be 6-7 quails for one section of 30 cm. square in summer, and 9-10 in winter.

4. The most suitable temperature for the laying room is 20°C. to 25°C. The laying efficiency suffers if the temperature is lower or higher than this. The quailmen try to maintain the temperature at about 23°C.

5. The domesticated quails lay eggs usually in the afternoon. Therefore, the cages have to be cleaned up in the morning, and it is necessary in the afternoon to keep the cages as quiet as possible. This is quite different from the case of the domestic fowl, which lays eggs usually in the morning.

6. Only female quails are put into the laying cages, and no males[1]. In olden times they would put one female into one cage and, introducing a male quail into the cage every morning, make them copulate. Now, this old method is not employed in raising quails. Six to ten female quails are fed in each section of a cage, as above-mentioned, and no male is mixed with them. In order to obtain fertilized eggs for breeding purposes usually one male and two females, or two males and six females are kept together in one cage.

7. The laying quails, hatched in spring, keep laying eggs until next spring. During the whole period they are kept day and night under artificial light. When the demand for quail eggs becomes slight in summer, the majority of the laying quails are diverted to meat. Only the breeding quails are held for more than two years.

8. The quails which have stopped laying eggs are fed with grains such as Barn-yard Millet, German Millet, etc., for three weeks before being diverted to meat. The flesh becomes more delicious during the period.

Present state of Japanese Quail-breeding Industry

There have been remarkable vicissitudes in the raising of the domesticated quail as a delicacy. In recent years the production was most flourishing in 1947. The annual amount of stock ran to 2,000,000, and after that year gradually decreased 1,000,000 in the spring of 1955. These figures refer to the approximate number of female quails because, as mentioned above, only the female quails are reared. The laying efficiency is as high as about 80% during fall to winter, so that about 1,600,000 eggs would be produced per day by 2,000,000 laying quails. But the sales system was imperfect and each producer was selling eggs individually. Thus, when the production reached its peak, it suddenly turned into over-production,

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[1] Takatsukasa (1921), p. 26

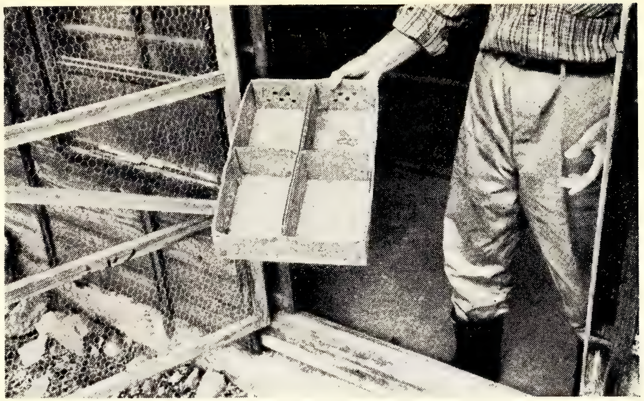

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Photo 1. Packing box for day-old chicks (25 quails per section, 100 quails per box).

Photo 2. Brooding box. Day-old chicks are fed here for seven days. A hot water pipe runs under the box. The floor is a wire-screen. The electric bulb in each section is for lighting, not heating. About 160 quails are fed in each section, sized 2 × 3 ft.

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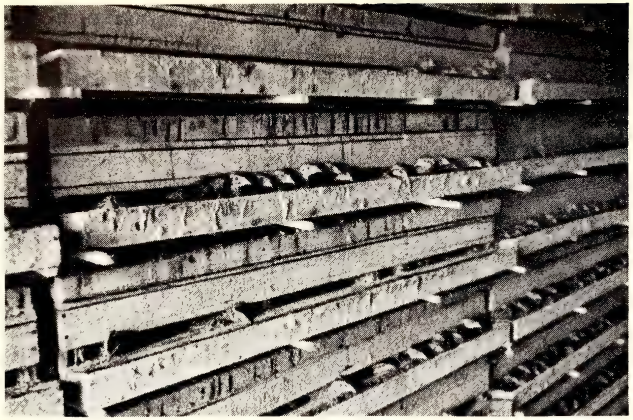
Photo 3. Cages for chicks 8–13 days old. The front side is covered with a wire-screen of 1·6 cm. mesh. The total number of chicks reared in these 36 cages is 1800.

Photo 4. Laying house for 10,000 quails. The right end of the house is a room for food supply.

Photos : Author



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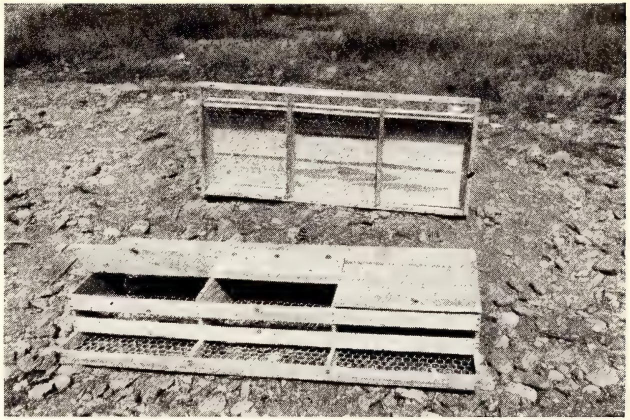

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Photo 5. Cages of pullets 14–30 days old.

Photo 6. Laying cage units. Each 3 × 1 ft., divided into three sections. In each section, 6–7 quails are reared in summer, and 9–10 quails in winter.

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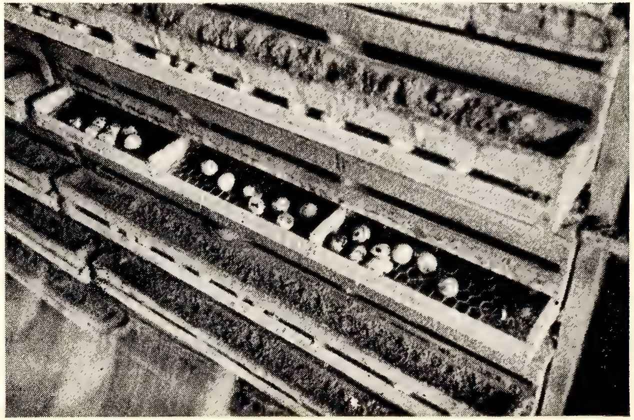

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Photo 7. Laying room. Eggs are seen under the food hoppers.

Photo 8. Laying room. A food hopper taken off, eggs pooled in the front side are seen.

Photos : Author

and the price of quail eggs fell heavily. Then the production was reduced, and thus the same process was repeated.

During the last one or two years, many quail-producers' associations have been formed aiming at finding and extending the market, and so the quail-breeding industry is now tending to stability.

The leading districts in the quail industry are Toyohashi City and Tokyo City, and their vicinities. Two-thirds of the entire output of Japan is produced in these two areas. A specialized quail producer usually possesses 20,000-30,000 quails, and a subsidiary quail producer usually keeps 300-1000 quails. The retail price of an egg in Tokyo is yen 4 to yen 5,[1] and is tending to decline. In general, the amount of powdered food necessary for 10,000 quails per day is 225 kg., which means 22.5 g. per quail per day. On this basis, and with the various other items of expenditure, the cost price of one egg works out to only yen 2 or a little more. Besides that, about 11 grams of droppings is daily produced by one quail. The droppings are in demand as an effective fertilizer and furnish a subsidiary income for the quailman. In summer season when the demand for quail eggs is slight, the majority of the quails older than one year are disposed of for the purpose of meat. The birds are kept frozen and consumed in fall to winter as delicious meat. So, the quail industry has very bright prospects if the market would be extended by promoting the co-operative system among the quail producers.

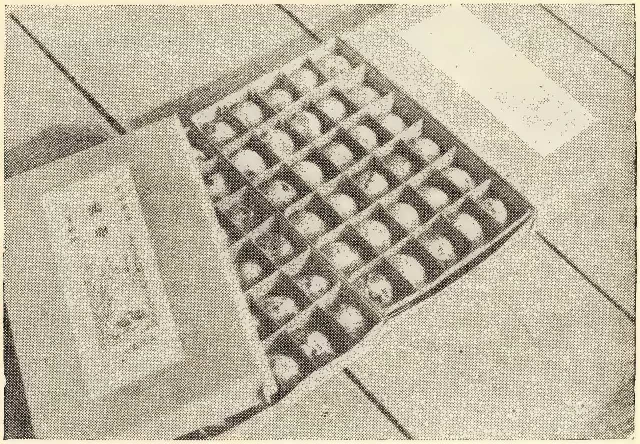

Photo 9. Packages of eggs sold in shops

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[1] One yen = about 1.3 nP. One U.S. dollar = 360 yen = Rs. 4.75.

SUMMARY

The wild quail, *Coturnix coturnix japonicus* Temminck, has been domesticated in Japan and is supplying eggs and meat for table use on the scale of an industry. The domesticated quail shows a high laying efficiency of 80% (250-300 eggs during the first year).

Quail breeding, since it offers a satisfactory alternative supply of large quantities of delicious quail meat and eggs, is an answer to the difficult question of how to reconcile the age-old custom in Japan of the eating the meat and eggs of wild birds with the preservation of the wild birds that still remain. The problem, however, has not yet been completely solved but, when the industry is properly organized and production expanded and stabilized, it is hoped that the desired solution may be found.

ACKNOWLEDGEMENTS

My sincere thanks are due to Dr. Sálim Ali, Mr. Aiji Ito, and Masahi Yoshii for their kind help in various ways.

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Some Observations on the Behaviour of the Incubating Redwattled Lapwing, *Vanellus indicus indicus* (Bodd.)

BY

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(*With one plate and two text-figures*)

Reactions of brooding birds to the external environment, physical as well as biological, are of special interest to ornithologists. With the advent of the breeding season, profound changes appear in the behaviour of birds and these changes may be due to changes in their physiological state. Even though our knowledge of these physiological changes is incomplete, their ultimate effect on behaviour, at least in certain cases, is better understood. More factual information on breeding behaviour, therefore, is of importance in understanding the evolutionary pattern in bird behaviour.

The present work records some observations made on the behaviour of a pair of nesting Redwattled Lapwings [*Vanellus indicus indicus* (Bodd.)]. Since this bird lays on bare ground exposed to the sky and not in the shade, the eggs have to be protected against (1) changes in the physical environment, (2) egg predators, and (3) cursorial animals likely to trample upon the eggs inadvertently.

The nest, when discovered on 27 April 1960, was just a shallow pit made in open ground, and contained the complete clutch of four eggs. Even though the field in which the nest was situated was surrounded by luxuriant evergreen trees, the nest was exposed to solar radiation throughout the day because it was situated right in the middle of the barren field, from which a crop of jowar had already been harvested.

For closer observation and photography, a small inconspicuous hide was erected at a distance of five feet from the nest. The birds soon got accustomed to the presence of the hide, which obviously altered the original barrenness of the surrounding area. Since sexual dimorphism in the Lapwing is not distinct enough for quick field identification, it was necessary to mark at least one bird, so that one member of the pair could be distinguished from the other. Initially, several unsuccessful attempts were made to mark the bird by spraying paint on it with a large syringe. This had to be done from the hide and, owing to the narrow field of view through a small opening in the hide, the bird could not be accurately aimed at, every time the bird moving quickly away from the site. After several attempts a few drops of paint did stick on the back of the bird, but they were not conspicuous enough against the dark plumage. It was therefore decided to capture the bird for marking. This was accomplished with the help of nylon mist nets. Since the nets used had a mesh size of 1 in. and were designed to capture birds much smaller than the lapwing, we had to use them in a slightly unconventional manner. Two mist nets were installed at an angle to one another at a distance of about ten feet from the nest, in such a way that these nets formed the two sides of an equilateral triangle with the hide as the base, and the nest in the centre of the triangle. A gap of about eight inches was left between the lower border of the nets and the ground. After setting this trap, one of us took cover in the hide and sat waiting for the bird to return. This was done late in the morning, well after sunrise, since the bird would soon return to the nest because of its anxiety to keep it protected from the blazing sun. The bird, which till then was observing our movements, quickly made towards the nest site from the direction opposite to the hide, in spite of the fact that the nets, without any dark background, were clearly visible even from a considerable distance. When the bird came very close it paused for a few seconds, then walked a couple of steps along the side of the net and, ducking a little, passed through the gap under the net. Once inside the enclosure it walked straight to its nest and sat on the eggs, wary and watchful, looking from time to time at the unfamiliar sight of the nets. After a few minutes the hiding observer came out all of a sudden without giving any previous warning to the bird. Upon this the bird hurriedly got up, took a step or two and flew off in the opposite direction right into the net. Before the bird had time to get out of the net, it was grabbed. The white patch on one side of its neck was adequately painted red with alcoholic eosine stain. The nets were quickly removed and the bird was released. It flew away fast, greatly agitated, uttering continuous sharp notes, and disappeared towards its feeding ground. Instantaneously, its mate came hurriedly flying from the same direction and uttering similar notes. But by that time we had already moved away to a distant observation post. The unmarked bird flew around the field in a complete circle but, seeing no visible sign of danger, alighted on the border of the field and walked hurriedly straight to the nest, all the while uttering sharp notes. On reaching the nest it appeared reassured and quickly sat on the eggs. The birds were left to themselves and for the rest of the day no further observations were made. A reference to existing literature and our own observations made during the subsequent days made it obvious that the marked bird was female, and the unmarked one the male. The male was found to relieve the female from duty at the nest only during the hotter part of the day, and while at the nest he appeared more wary and watchful than the female. In the description to follow, the marked and the unmarked birds will be referred to as female and male respectively. At no time was any lapwing other than these two birds observed around the nest site.

Two days after marking the bird, the movements of the pair around the nest were watched continuously for eleven and half hours. In order to avoid any disturbance which might modify the movements of the birds at the nest site, the hide was abandoned on that day and, instead, all the observations were made from a distance of about 150 feet with a pair of binoculars, and recorded on the spot. Later, for twenty days the birds were observed at least for a few hours daily. We were then expecting the young ones to hatch out any day. But, as fate would have it, one early morning before sunrise when it was still dark, the owner of the field inadvertently destroyed the entire nest while ploughing. However, he left the hide undisturbed, because, as he said afterwards, he knew that we were doing something of importance inside the hide, but did not know that our object of study, which made us sit within the hide, often in blazing sun, was in fact outside it !

The following are the observations made on the behaviour of this pair of lapwings, presented under appropriate headings.

Rhythm of activities at nest site:

The sequence of events presented below is based on continuous observations made during eleven and half hours on a single day. The notes are just as they were recorded on the spot in our field-notebook:

6-30 hrs. No bird on the nest. Male standing at a distance of about 30 feet from the nest.

6-45 hrs. The female arrives on the scene and is seen standing at a distance of about 80 feet away from the nest and preening its feathers.

7-01 hrs. A dog happens to cross the field. When it comes to a distance of about 40 feet from the nest, the female stops preening and flies towards the dog. Uttering sharp notes, it makes some attempts at pecking the dog. Attention of the dog is drawn towards the bird. The bird now flies quite low, alighting from time to time on the ground in front of the dog, but always remaining about eight feet away from it. When the dog is about 250 to 300 feet away from the nest, the bird stops luring it further. This entire operation is completed within 3.75 minutes. The male is not to be seen anywhere around.

7-42 hrs. The female from the border of the field walks to the nest.

7-44 hrs. The female sits on the eggs.

7-47 hrs. The female gets up and leaves the nest.

7-52 hrs. The sun rays start spreading over the field.

7-54 hrs. The female returns once again to the nest and starts incubating. The male appears on the scene.

8-14 hrs. The female leaves the nest.

8-15 hrs. Both the male as well as the female are seen attacking and chasing away a crow from the field.

8-27 hrs. The female returns and sits on the eggs.

8-33 hrs. The male attacks a crow near by, while the female continues to incubate.

8-43 hrs. A kite flies about 50 feet high over the nest. The sitting female reacts to it by straightening out neck and tail, keeping them parallel to the ground.

10-00 hrs. The male comes to the nest and takes over from his mate the duty of covering the eggs. The female walks away from the nest.

10-26 hrs. The female flies away from the scene.

10-46 hrs. The female returns.

11-07 hrs. The female comes to the nest and takes over incubation from the male. The male disappears from the scene.

11-45 hrs. The male appears on the boundary of the field and walks briskly straight to the nest.

11-46 hrs. The male relieves the female from duty at the nest. The female walks to the border of the field and waits in the shade of a tree.

12-18 hrs. The female takes charge of the eggs from the male. The male walks away and waits in the tree shade.

13-03 hrs. The male takes charge of the eggs from the female, which in turn walks away to the shade.

13-07 hrs. The female disappears from the scene.

13-47 hrs. The female re-appears.

13-52 hrs. The female goes to the nest and relieves the male. The male walks to the tree shade.

13-57 hrs. The male flies away from the scene.

14-33 hrs. The male re-appears.

14-36 hrs. The female is relieved at the nest by the male. The male sits on the eggs. The female walks away.

14-39 hrs. The female flies away.

15-09 hrs. The female arrives.

15-11 hrs. The female takes charge of incubating from the male. The male walks away and stands under a tree.

15-44 hrs. The male flies away from sight.

15-58 hrs. The male returns.

16-02 hrs. The male takes charge of the eggs from the female.

16-03 hrs. The female disappears.

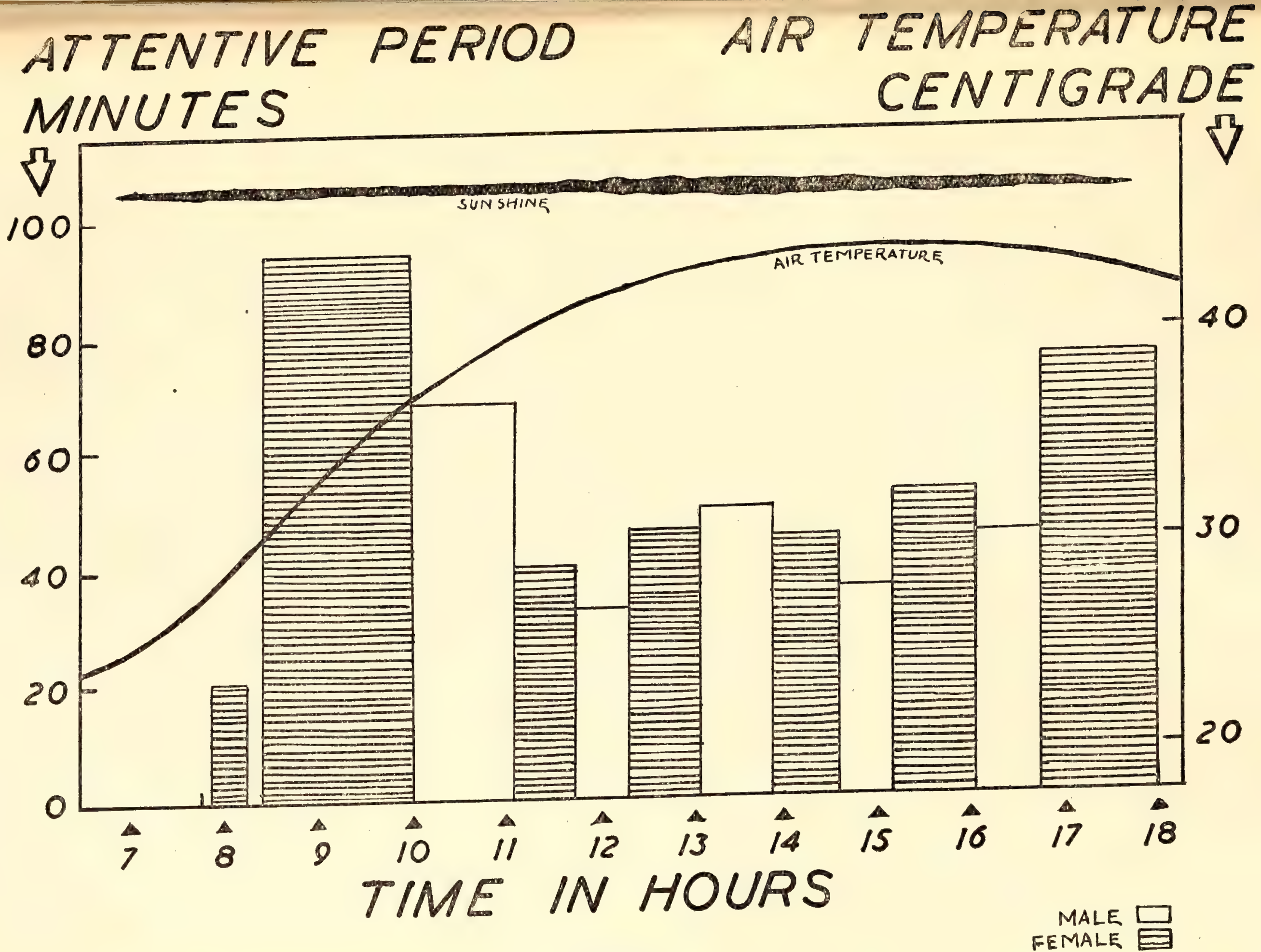
16-39 hrs. The female returns.

16-46 hrs. The female relieves the male at the nest.

18-00 hrs. The female is still sitting on the eggs when watching terminates for the day.

Protection of eggs against solar radiation:

Figure 1 is a histogram showing the attentiveness of the birds at their nest during day time, based on the observations presented above. From the figure it is clear that in the early morning, and probably also in the late evening, the eggs are covered by the female alone, whereas during the crucial part of the day when the air temperature is high and solar radiation intense, the male and the female attend the nest in turns. In the morning when the air temperature is low, the eggs may remain uncovered for varying intervals of time. But from 8-30 a.m. onwards



Text-fig. 1

Histogram of attentiveness at the nest of Redwattled Lapwing in relation to air-temperature and sunshine

The air-temperature and sunshine were recorded at the M. S. University Meteorological Observatory, about half a mile away from the nesting site. The thickness of the sunshine line indicates the intensity of solar radiation. Observations began at 6.30 hrs. and ended at 18 hrs.

the eggs are kept continuously covered. While changing duty at the nest, the sitting bird will get up only after its mate has approached very close to it (Plate, Fig. 1), so that the eggs remain uncovered only for a brief interval.

Incidentally, the question arises whether the lapwing sitting on the nest actually incubates, i.e. applies heat to, the eggs. It has been shown in several species that the bird may sit over the eggs without applying heat to them (Van Tyne & Berger, 1959). Thus, sitting on the eggs does not necessarily mean incubating, but this could be ascertained correctly only by placing thermo-couples in contact with the eggs. However, the lapwing when about to sit on the eggs, raises the breast feathers (Plate, Fig. 2) so that when it sits down, the eggs probably come in contact with skin. Thus, when the lapwing is sitting on eggs in the daytime it is not merely covering them to shade them from the sun's rays but it is probably incubating them as well.

Since the bird on duty at the nest sits exposed to solar radiation, it has to protect itself against rise in body temperature. As the day advances the changing over of duty at the nest occurs more frequently. Between 11 a.m. and 3 p.m. the frequency of the change-over is highest, a change-over taking place approximately every 40 minutes. But later on as the day advances further the frequency of the change-over decreases. During the hotter part of the day, the bird sitting on the nest is seen continuously panting and pulsating the gular area and raising up its feathers whenever there is the slightest breeze (Plate, Fig. 3). This is mainly to facilitate evaporative cooling. On the other hand, the bird, as soon as it is relieved at the nest, seeks the tree shade.

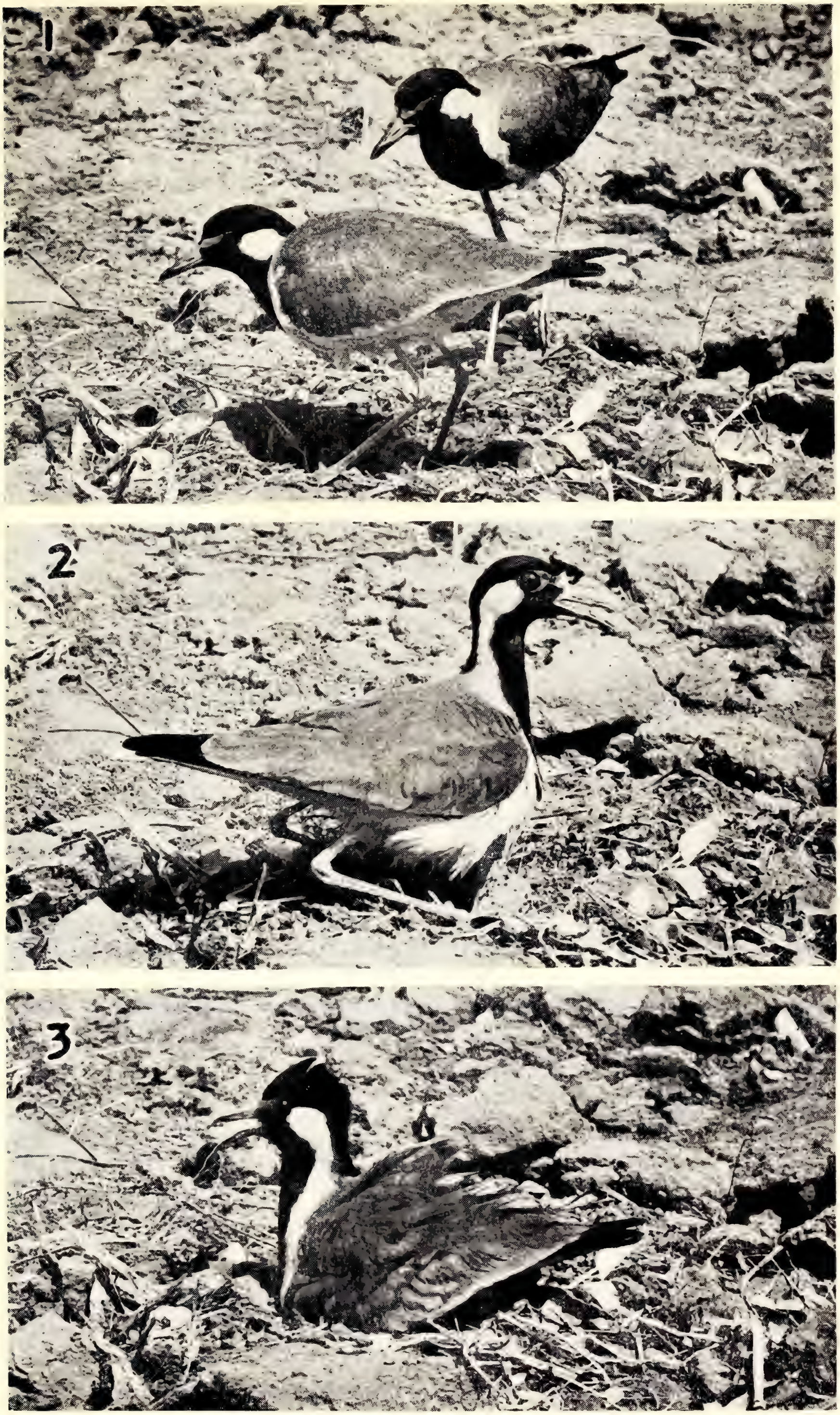
Protection of eggs against predators and cursorial animals:

During the course of observations we had the chance to observe the reactions of the lapwing towards kites, crows, dogs, cattle, and humans.

The bird sitting on eggs, owing to its broken colour pattern of black and white on the neck and the dull coloration of the back, matches very well with the shadows cast by earthen clods scattered all over the field. The lapwing has this advantage of camouflage only because it nests on open ground and never in the shade of a tree. Moreover, during the heat of summer, when the shade of the trees is much sought after by arboreal and cursorial animals, the ground under a tree is a highly unsafe place for the bird's nesting.

To any approaching intruder, whether a crow or a kite flying overhead, or cattle grazing around, or a human crossing the field, the first reaction of the incubating bird is to straighten out head, neck, and tail, keeping them parallel with the ground, and at the same time to freeze all movement, so much so that the bird even stops the gular pulsations.

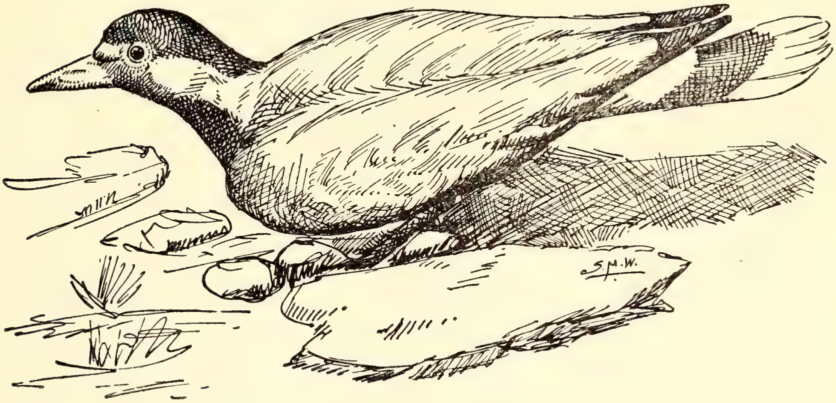
Redwattled Lapwings at the nest



1. Changing over of duty at the nest. 2. Bird about to sit on eggs. Note the raised up breast feathers. 3. Bird sitting on eggs. Feathers on back and head raised up and mouth kept open to cool the body. (All the photographs were taken before marking the bird.)

Photos : Authors

Probably this is an attempt to enhance its camouflage. But if the intruder is cattle, it may continue to move towards the nest, hardly noticing the bird. In such a case, when the animal approaches within about 10 feet from the nest, the lapwing without shifting other parts of the body, suddenly spreads out its tail, exposing the black and white bands to advantage (Text-fig. 2). This serves as the flashing of a danger signal, and arrests the intruder's notice immediately. A bullock on observing this signal stopped advancing further, paused staring at the bird for a short time, and then quickly moved away from the nest, whereas a young buffalo which was very much agitated to observe this signal, jumped with a start and ran away from the site.



Text-fig. 2

Characteristic freezing pose of the Redwattled Lapwing, with raised tail showing black and white bands. This pose is assumed to frighten off approaching cattle. The sketch is traced from a kodachrome transparency.

On the other hand, the lapwing was never observed to show this danger signal to a human. On seeing a human approaching, the sitting bird at once assumes the camouflage or freezing posture. If the person advances further, the bird slowly and quietly gets up from the nest and starts walking away in the opposite direction pretending as if nothing had happened. This entire manoeuvre is so skilfully performed that it avoids unduly attracting the attention of the trespasser. Many a time we had to visit the nest for examining the eggs ; at every visit, the bird, after walking away 50 to 100 feet from the nest, would stop to observe our movements. But if we started handling the eggs, it would immediately start uttering continuous sharp cries and walking towards us. Once when we were engrossed in weighing and marking the eggs, the bird approached as close as ten feet from us.

Discussion

All the birds nesting in this part of the country in summer are subjected to intense heat. Even birds like the Indian Robin (*Saxicoloides fulicata*) nesting within a house, and the Purple Sunbird (*Nectarinia asiatica*) with a shaded nest, continuously pulsate the throat with the heat while incubating at noon (unpublished observation). In both these birds, it is the female alone that incubates, and that seems possible only because they nest in shaded places. Since the lapwing's nest is fully exposed to solar radiation the incubation if attempted by the female alone could be fatal to her, and that is why the attentiveness shown by the male at noon in periodically relieving her becomes all the more significant. The rise in temperature could be partly, if not solely, responsible for the development of attentiveness in the male at noon. Since this bird continues to nest even after the onset of the monsoon, it would be most interesting to compare the relative degree of attentiveness in the two sexes on a cloudy day, when the weather is cooler.

The present observations give further support to the fact that the survival of eggs exposed to adverse conditions depends largely upon the behavioural pattern of the parent birds. Many a time such behaviour of the bird has great survival value for its eggs or young, but less or none for the bird itself. The lapwing, sitting on eggs in the intense heat of the mid-day sun, or landing conspicuously, or flashing its conspicuous tail pattern in front of an intruder, has little survival value for the bird itself, but it does ensure protection to its eggs. In the animal world greater emphasis is placed on the continuous propagation and survival of the species, rather than on the survival of a mere individual.

Summary

This is a record of observations made for twenty days on the behaviour of a pair of Redwattled Lapwings at a nest containing eggs. The relative attentiveness of the sexes and the reactions of the birds to temperature, predators, and cursorial animals are described, and their significance postulated.

Acknowledgement

We are thankful to Prof. D. V. Gogate, M.S. University, Baroda, for supplying the data on air-temperature and sunshine.

Reference

Van Tyne, J. & Berger, A. J. (1959): Fundamentals of Ornithology. John Wiley and Sons, Inc., New York.

On some Larval and Juvenile Stages of three species of Fish from the River Jamuna at Allahabad[1]

BY

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(*With four text-figures*)

INTRODUCTION

In the course of investigations on the breeding habits and spawning season of the common freshwater fishes of the rivers Ganga and Jamuna at Allahabad during the first half of 1958, a large number of developing eggs, early larvae, and fry of several species were collected, many of which are already well known and have been described in the literature. The work prior to 1950 was summarised by Jones (1950) in his bibliography of the breeding habits and development of the fishes of the inland waters of India. Notable contributions have been made since then by Alikunhi (1955), Alikunhi & Chaudhuri (1954), Karamchandani & Motwani (1954, 1955, 1956) and Pakrasi & Alikunhi (1952).

The present communication deals with the larval stages of two cyprinids *Barilius vagra* (Hamilton), *Oxygaster gora* (Hamilton), and a mugilid *Liza cascasia* (Hamilton).

MATERIAL AND METHOD

The material for the present study was collected from the River Jamuna near Sujawan, about 10 miles upstream of its confluence with the River Ganga, during the months of March to May 1958. Collections were mostly made from the Dan fishing vessel by towing one-metre and half-metre ring nets of organdi cloth. The larvae were then sorted in the laboratory and reared to obtain connected series to identifiable stages. Most of the camera lucida drawings were made from freshly preserved material, but in a few cases live specimens narcotised in menthol were also used. The lengths of the different stages in the text indicate total lengths.

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[1] Published with the permission of the Chief Research Officer, Central Inland Fisheries Research Station, Barrackpore, 24-Parganas, W. Bengal.

Barilius vagra (Hamilton)

The species is frequently encountered in the commercial catches at Allahabad during early summer months, when small-meshed drag nets are operated, but it does not constitute a fishery of more than minor importance. Numerous larvae and juveniles of the fish were collected from the River Jamuna in the month of March. According to Day (1878), this species attains about six inches (=152 mm.) in length. Specimens ranging between 130 to 150 mm. occur in commercial catches.

LARVAL STAGES

4.80 *mm. stage* (Fig. 1, a) : This is the earliest available stage and shows the mouth as being well developed, and slightly oblique. The eyes are large. The yolk sac is still present and so also the dorsal and anal fin folds, the latter showing a swollen contour in the position of the future anal fin. The tip of the notochord is slightly upturned. The pectoral fins are rudimentary. The larva has 19 countable myotomes present at this stage. Three large chromatophores are present along the mid ventral line in the post-anal region of the body, while a few large and small ones occur in the occipital area. A few scattered chromatophores are also present along the dorsal and postero-ventral sides of the yolk sac.

6.70 *mm. stage* (Fig. 1, b) : The mouth is oblique and prominent. All the fins are present, but still rudimentary, and the dorsal and anal fins show seven and ten ill-defined rays respectively. The tip of the notochord is sharply bent upwards. The myotomes of the larva have now increased to 25. The chromatophores numbering seven and six are respectively arranged in a characteristic pattern along the mid-dorsal and mid-ventral line along the base of the dorsal and anal fins. A double row of chromatophores is present on the lateral side of the body of which the upper one runs from the middle of the caudal peduncle to the posterior border of the orbit, while the lower row ends ahead of the anal fin. A few scattered chromatophores are seen in the shoulder and occipital regions.

10.00 *mm. stage* (Fig. 1, c) : The shape of the mouth is more or less like that of the adult. The posterior end of the maxilla reaches to the middle of the orbit. All the fins are now almost fully formed with their respective number of rays. The upper half of the body has become slightly brownish and the number of chromatophores described in the preceding stages are now less. The double row of chromatophores of the earlier stage has now merged into a single row, arranged in the form of a chain running from the base of the caudal to the pre-dorsal region, giving the appearance of a thin dark line. The small patterns of chromatophores on the occiput and pectoral regions still persist as also the post-dorsal and post-anal chromatophores.

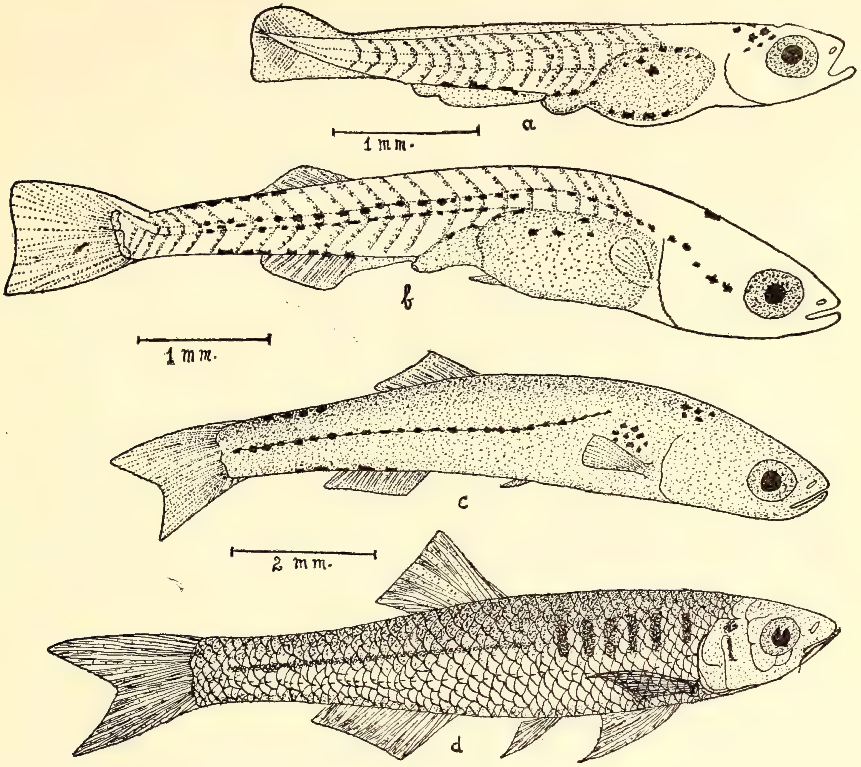

Fig. 1. Larval stages of *Barilius vagra* (Hamilton)

24.00 *mm. stage* (Fig. 1, d) : With growth from the post-larval stage described above, to the juvenile condition, several changes are noticed. By now all the fin rays are well formed. The maxilla is well developed and extends to below the middle of the orbit. A pair of maxillary barbels has appeared. At this stage, the upper half of the body becomes brownish, and the lower half yellowish. On the side of the body above the pectoral fin, six transverse bands are present. The thin dark lateral band of the preceding stage still persists and is seen upto the 38-40 mm. size.

The early stages of *B. vagra* indicate that the dorsal fin is situated nearer to the base of the caudal fin than to the head. But at the 24 mm. stage the dorsal fin is nearer to the head than the caudal base. With growth the anal fin also slightly moves forward lying below the dorsal fin. The following characteristic features were observed in the specimens ranging between 27 and 50 mm. in total length.

The length of the head is 5.2 to 5.4 and the maximum height of the body is 5.8 to 6.1 in the total lengths. The eyes are large, the diameter being contained 3.3 to 3.7 in the length of the head. The posterior end of the maxilla reaches to below the middle of the orbit. The upper half of the body is brownish tinged with olive and the lower half is yellowish. As the fish grows more transverse bands appear which eventually number from 10 to 12 in the adult.

TABLE I

Barilius vagra (Hamilton)
(Measurements in millimetres)

Characters	Larval Stages			
	4.80 mm. stage	6.70 mm. stage	10.00 mm. stage	24.00 mm. stage
Standard length	3.80	5.40	8.20	18.00
Length of head	1.05	1.54	2.35	5.00
Length of snout	0.31	0.40	0.55	1.50
Diameter of eye	0.42	0.54	0.88	2.00
Maximum height of body	0.94	1.54	1.70	5.50
Length from vent to tip of caudal fin	2.45	3.20	4.50	11.00

Oxygaster gora (Hamilton)

This species is found to be quite common at Allahabad and forms a minor fishery of some importance in the months of November to April. The largest specimen recorded in the commercial catches is 274 mm. in total length. The larvae of this species were collected mostly in April and juveniles from May to July. *O. gora* is essentially Indo-Gangetic in distribution.

LARVAL STAGES

4.40 *mm. stage* (Fig. 2, a) : This is the earliest stage collected. The body of the larva is elongated. The mouth is superior and markedly upturned. The dorsal and anal fin folds are continuous, the latter being interrupted by the formation of the anal opening, thus splitting it into pre-anal and post-anal parts. The pre-anal fold extends to the 18th somite, while the post-anal is continuous with the caudal fold. The tip of the notochord is straight. Rudiments of pectoral and pelvic fins are present. The eyes are large. The body has 25 somites.

6.30 *mm. stage* (Fig. 2, b): The mouth is still superior and strongly oblique. The dorsal and anal fin folds have now been transformed into fins with 9 and 8 rudimentary fin rays respectively. The pre-anal fin fold still persists. The tip of the notochord is now directed upwards. The pectoral and pelvic fins are with their respective rays. The body of the larva has 48 somites. Arranged along the mid-ventral line, there are nine post-anal chromatophores. The two pre-anal rows of chromatophores running parallel to each other have fourteen and eleven chromatophores in the lower and upper row respectively.

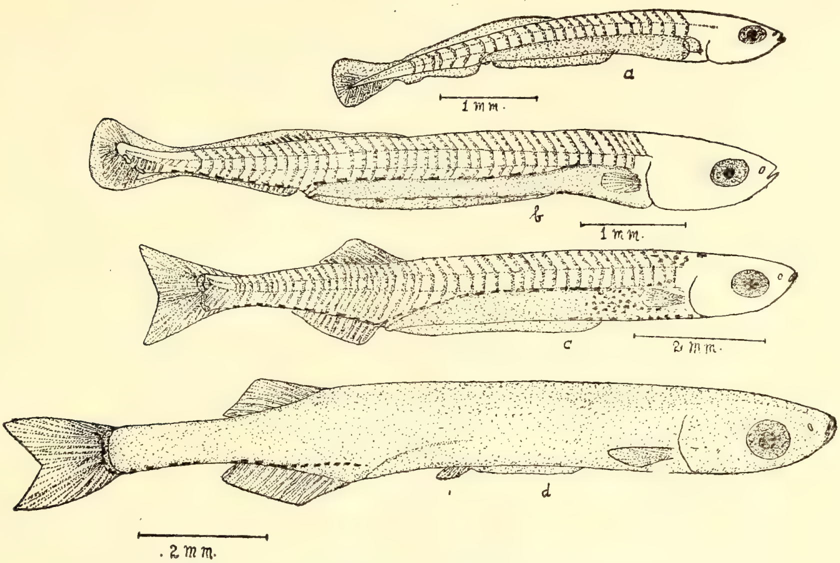

Fig. 2. Larval stages of *Oxygaster gora* (Hamilton)

9.25 *mm. stage* (Fig. 2, c) : The mouth is still superior and oblique and the larva resembles more or less the adult in body shape. The dorsal and anal fins appear to have slightly shifted forward. Both the fins have assumed their normal shape and are characterised by 10 and 11 rays respectively. The caudal fin is of the homocercal type. The arrangement of the chromatophores is more or less the same as in the preceding stage, with the exception of some addition in number. Clusters of small chromatophores are present in the occipital region and in the area below the pectoral fin.

12.10 *mm. stage* (Fig. 2, d) : At this stage, it is more or less a juvenile specimen, with all the characteristics of the adult. The mouth is directed obliquely upwards, lower jaw fitting into the groove of the upper jaw. The dorsal and anal fins have 10 and 16 fin rays respectively as in the adult. The vestige of the ventral fin fold still persists. Excepting the post-anal row, all the chromatophores have disappeared, and their number is now sixteen.

During the study of larval and post-larval stages of *O. gora* in their developmental history, it has been found that the position of the dorsal and anal fins has shifted backwards at every stage. The fins appear to assume their normal position by about the 29 mm. stage.

Some of the diagnostic features of *O. gora* as observed in specimens ranging from 35-80 mm. are given below.

The body of the fish is laterally compressed and the ventral surface is keeled. The mouth is directed upward. The length of the head is 5.0 to 5.4 and the maximum height of the body is 6.0 to 6.4 in the total length. The diameter of the eye is contained 3.7 to 3.9 in the head length. The sub-orbital ring of bones is broader than the diameter of the eye. The scales on the head extend to the nostrils. The colour of the body is silvery.

TABLE II

Oxygaster gora (Hamilton)

(Measurements in millimetres)

Characters	Larval Stages			
	4.40 mm. stage	6.30 mm. stage	9.25 mm. stage	12.10 mm. stage
Standard length	3.62	5.32	8.00	10.21
Length of head	0.80	1.21	1.50	2.17
Length of snout	0.20	0.30	0.54	0.73
Diameter of eye	0.27	0.30	0.56	0.67
Maximum height of body	0.57	0.75	1.12	1.34
Length from vent to tip of caudal fin	1.48	1.94	3.50	5.00

Liza cascasia (Hamilton)

L. cascasia, a small mugilid fish growing to about 120 mm. in size, is very common in the rivers Ganga and Jamuna, and is always found moving in shoals along the banks. It constitutes a minor fishery at Allahabad in the months of November to March, and is caught in small-meshed drag nets in fairly large quantities. The larvae and juveniles of this species were collected in April and from June to August respectively, from the River Jamuna. According to Day (1878) *L. cascasia* occurs in the upper waters of the Ganges and Jamuna rivers, with Patna as the lower limit of distribution. It also occurs in the Brahmaputra.

LARVAL STAGES

4.70 *mm. stage* (Fig. 3, a) : The mouth is slightly directed upwards. The dorsal fin fold is continuous with the caudal, while the anal fold is slightly bulging in the prospective region of the anal fin. The tip of the notochord is straight. Body consists of 19 somites. There are five pre-anal and two large occipital chromatophores. Besides these, single large chromatophores are present on the posterior margin of the operculum and on the ventral side of the abdomen.

7.00 *mm. stage* (Fig. 3, b) : The mouth has become more prominent. The second dorsal fin has formed with six rudimentary rays. The anal

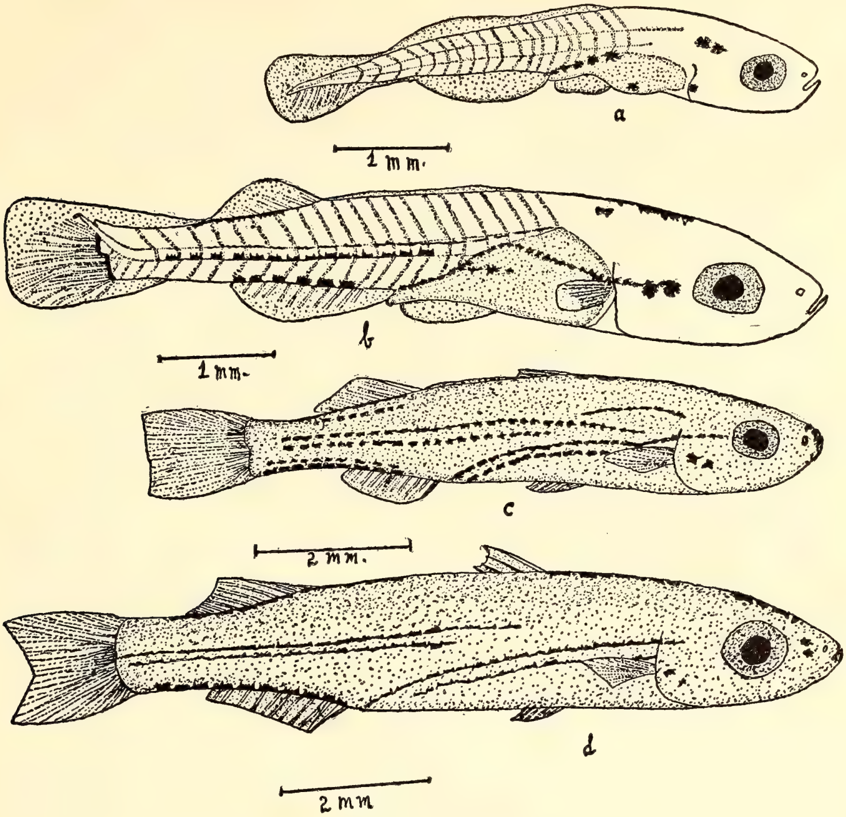

Fig. 3. Larval stages of *Liza cascasia* (Hamilton)

fin, which was a continuous fold has now 10 rays, and the pectoral fins are rudimentary. The tip of the notochord is sharply upturned. By now the larva has got 26 somites on the body. The pre-anal fold still persists. The chromatophores are now disposed in a distinct pattern. There are six large chromatophores at the base of the anal fin and a narrow band at the base of the dorsal. A chain of pre-anal chromatophores moves upward and then forward reaching the posterior margin of the eye; a few clusters are seen in the occipital region; along the lateral line on either side there is a distinct continuous row of chromatophores commencing from the base of the caudal and extending to the level of the base of first dorsal fin, and a dark band is present at the base of the caudal fin but disappears in the subsequent stages.

8.30 *mm. stage* (Fig. 3, c) : At this stage all the fins have been well differentiated. The first dorsal with 3 rudimentary spines has also developed. The dorsal and anal fins have now 7 and 11 rays respectively. The pectoral fins at this stage have 15 soft rays, and the pelvics have 1 spinous and 5 soft rays. The caudal is truncated. The arrangement of the chromatophores becomes more prominent, giving an appearance of dark lines.

10.00 *mm. stage* (Fig. 3, d): All the fins are fully differentiated with the adult number of rays, and the fin formula at this stage is : D. 4/1/8, P15, V1/5, A 3/8, C 14. More chromatophores have been added to make the pattern, already laid, more conspicuous and this characteristic colour pattern persists till the 40.00 mm. stage.

From the development of *L. cascasia* it could be said that the relative position of the first dorsal formed at 8.30 mm. stage remains practically unchanged in the subsequent stages of development while the second dorsal fin which was relatively nearer to the first dorsal base shifts backwards. The anal also shifts backwards and comes to lie below the second dorsal. The distinctive features described below were noticed in the specimens from 25 to 40 mm. in total length.

The mouth is wide its cleft being 1/3 of the extent of its gape. It is oblique, pointing upwards. The length of the head is 4.0 to 4.5 and the maximum height of the body is 4.9 to 5.2 in the total length. The diameter of eye is contained 3.2 to 3.7 in the length of the head. The first dorsal is much nearer to the snout than to the caudal peduncle. The second dorsal arises opposite the anal. The scales are ctenoid. The coloration of body is the same as in the last (10.4 mm.) stage. But as the fish grows further it becomes brownish above the lateral line and olive below.

TABLE III

Liza cascasia (Hamilton)

(Measurements in millimetres)

Characters	Larval Stages			
	4.70 mm. stage	7.00 mm. stage	8.30 mm. stage	10.00 mm. stage
Standard length	3.77	5.58	6.45	8.76
Length of head	1.17	1.87	2.00	2.38
Length of snout	0.32	0.58	0.59	0.85
Diameter of eye	0.41	0.67	0.90	1.00
Maximum height of body	0.80	1.22	1.50	1.80
Length from vent to tip of caudal fin	2.45	3.55	3.77	4.61

Development of scales in L. cascasia (Fig. 4): In *L. cascasia* the scales first appear on the body at the 10.00 mm. stage, and are all cycloid in structure. They first appear on the head and later on the rest of the body. At 14.10 mm. stage the scales are all cycloid and longer than broad. As the post-larva grows they develop more and more and at the 16.80 mm. stage, the head has typical cycloid scales. At a later

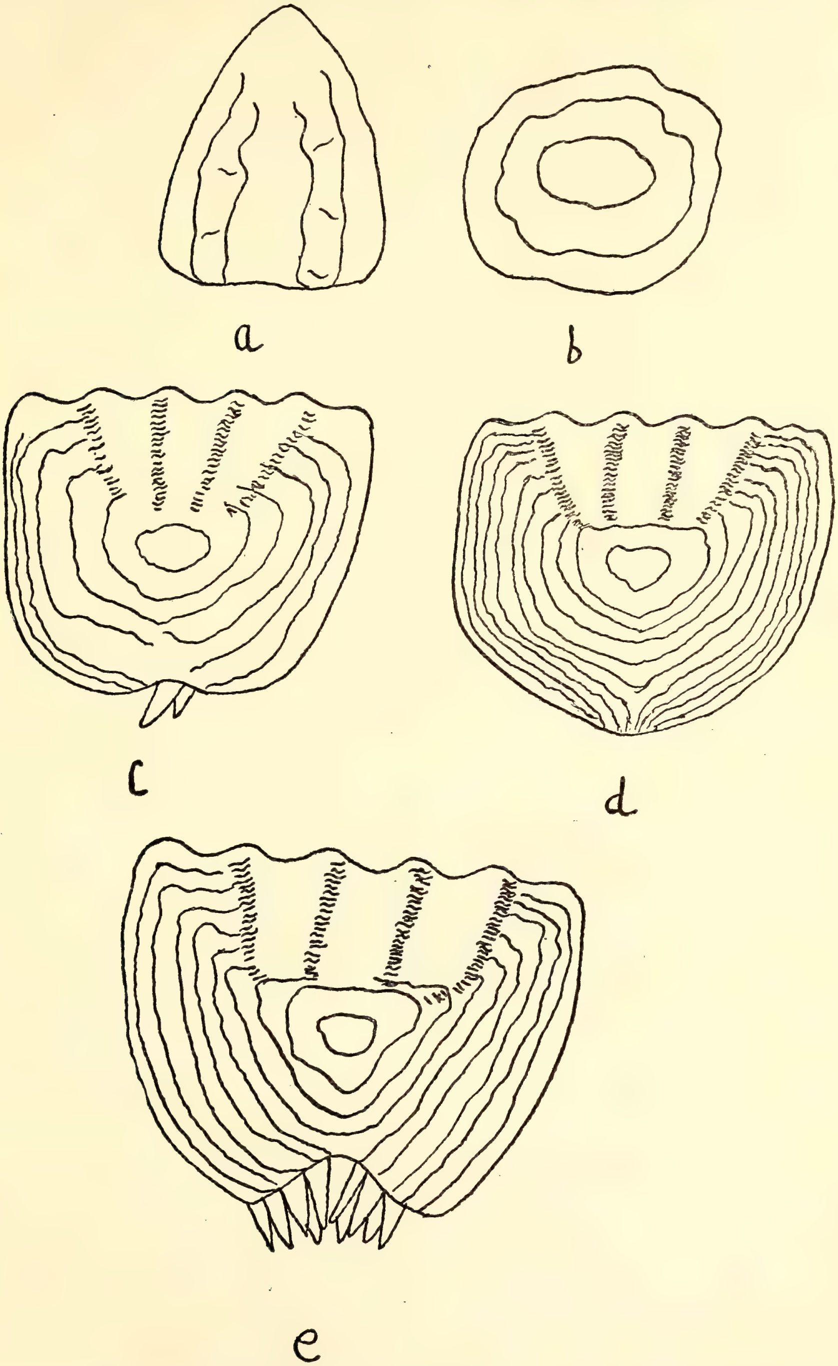

Fig. 4. Developmental stages of scales in *L. cascasia* (Hamilton).
(*a*) Cycloid scale from a 14.10 mm. long post-larva (*b*) same from the head region (*c*) Ctenoid scale from a 18.70 mm. long post-larva (*d*) Typical cycloid scale from a 30.20 mm. long specimen (*e*) Typical ctenoid scale from a 28. 70 mm. long specimen.

stage (18.70 mm.) the scales on the body have become ctenoid, in the majority one to two ctenae having appeared apically. The cycloid scales on the head have developed additional circuli.

With further growth, the scales assume the typical ctenoid pattern. A typical scale of a 28.70 mm. long fish has 7 to 8 circuli, 3 to 4 radii and about 8-9 ctenii. Cycloid scales with 10-11 circuli and 3 to 4 radii are fairly common. A typical cycloid scale from the head region has 11 to 13 circuli.

The pattern of the development of scales in *L. cascasia* parallels that of *Mugil corsula* described by Pakrasi & Alikunhi (1952).

As the work is of a preliminary nature it has not been thought necessary to refer to all the literature on the development of scales in *L. cascasia.*

ACKNOWLEDGEMENT

My sincere thanks are due to Dr. M. P. Motwani, Research Officer, Central Inland Fisheries Research Sub-Station, Allahabad, for suggesting this piece of work, and also for his constant guidance and encouragement during the period of the work. Thanks are also due to Dr. B. S. Bhimachar, Chief Research Officer, Central Inland Fisheries Research Station, Barrackpore, for going through the manuscript and making suggestions.

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Some Notes on Blanford's, or the Whitetailed Wood, Rat [*Rattus blanfordi* (Thomas)] in western India

BY

A. BROSSET

(*With one plate and one text-figure*)

Amongst the rodents, the genus *Rattus* is the best studied. The urban species, the Black Rat [*R. rattus* (Linn.)] and the Brown Rat [*R. norvegicus* (Berkenhout)] have been the subject of many works concerning their behaviour, their *psychic-faculties,* their reproduction, . . . etc., and their biology is very well known today.

In India, from the ecological point of view, we find two groups of rats, one associated with man, as *R. rattus* and *R. norvegicus,* and a second which shows no tendency to have anything in common with man, as Blanford's, or the Whitetailed Wood, Rat [*R. blanfordi* (Thomas)]. It would be interesting to compare the various other aspects of the lives of these two ecologically segregated groups.

Cohabitation with man has deeply modified the biology of the first group, and it is in the second group, which has undergone evolution free from human influences, that we must search for the primitive and natural biological characters of the *Rattus* stock.

For useful comparisons between these two ecologically segregated groups of *Rattus,* it is necessary to know the biology of both. But, though we know very well the biology of the town-rats, unfortunately nothing seems known about the others. The reason of this ignorance is easy to understand. In addition to the scarcity of field-mammalogists in India, these rodents are hill and forest species, living in secluded places. Like all small nocturnal mammals, they are usually extremely difficult to observe in their natural biotope.

During 1959 and 1960, I have made zoological researches on the fauna of the caves in western India, and have had the opportunity to observe several Blanford's Rats in their native haunts, and to collect some data on their life histories. Certain aspects of their biology, such as food and nocturnal territory, remain unknown, but

I have collected details about their diurnal biotope, social life, breeding behaviour, etc., and these observations, together with some comparisons with the biology of the town-rats, are the subject of the present note

CIRCUMSTANCES IN WHICH BLANFORD'S RATS WERE SEEN

Twenty-six rats were observed in their natural haunts. In all cases these rodents were in the darker, quieter, and most secluded parts of Buddhist caves all in hilly country.

Bedsar Caves (Western Ghats, Poona District):

On 4th June 1960, in a dungeon adjacent to one of the principal caves, my attention was drawn to a crevice in the wall, from which a strong smell of rodent-urine was emanating. Inside, five Blanford's Rats, a pair of adults and three young ones, were squatting. The rodents were on bare stone, and there was no trace of a nest. To catch them, we smoked out the rats with sulphur for a long time before we succeeded.

Aurangabad Caves, Deccan:

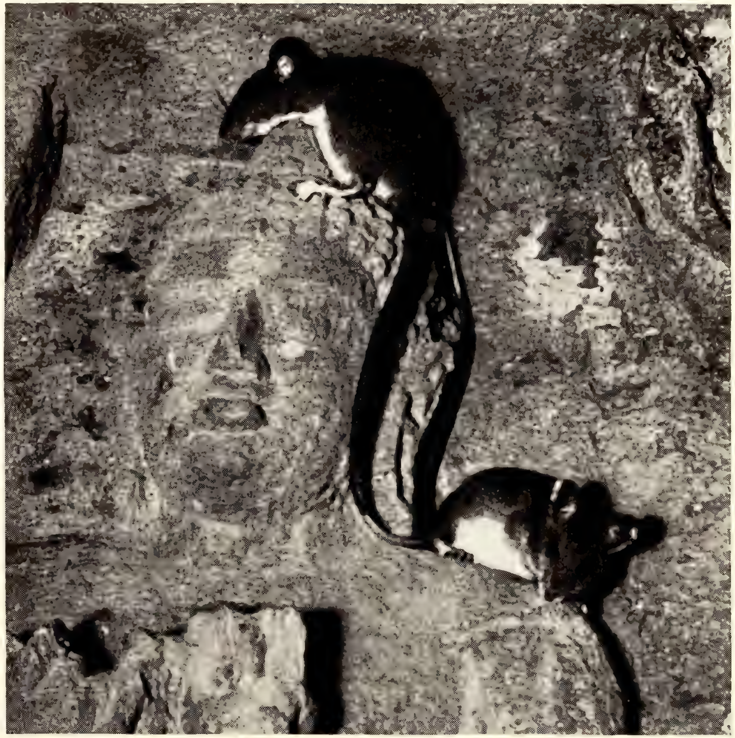
I paid a visit to the caves early in the night of the 28th August 1960, wishing to observe the nocturnal behaviour of the bats living there. About one hour after sunset, in a dungeon adjacent to one of the caves, I saw two sub-adult *R. blanfordi*. In the dungeon there was also a small colony of Indian Vampire Bats, *Megaderma lyra*. Rats and bats were very active, and seemed ready to go out of the caves, which they did immediately after my intrusion.

Half an hour later, in one of the open caves, I met a third Blanford's Rat. This rodent was sick, and probably blind. His eyes were covered with a whitish disc. Half the body was denuded of hair, and it was very thin.

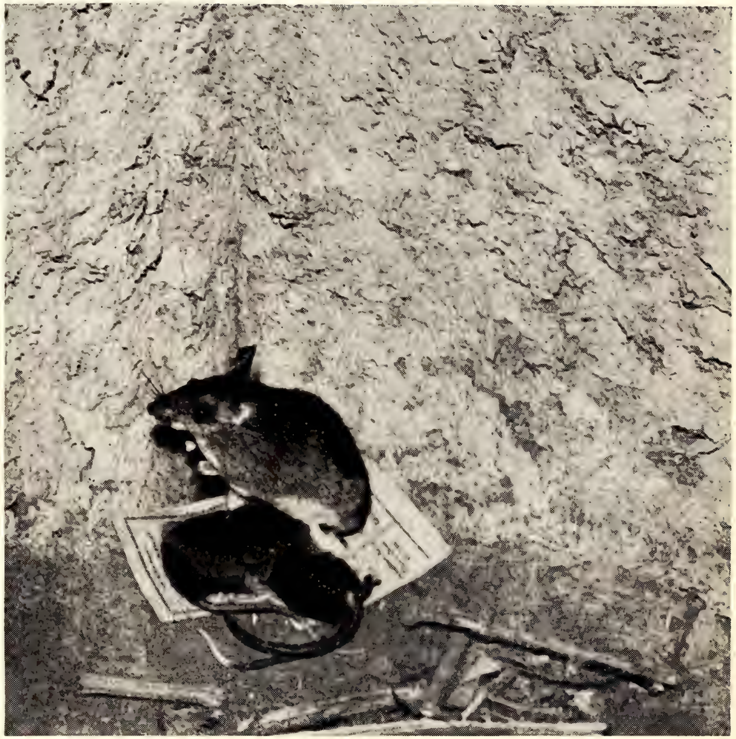
Kanheri Caves (Salsette Island, Greater Bombay):

It was here that I was able to follow the life of several individuals. In fact, I have visited these caves regularly, on an average once in every month since August 1959 to January 1961. During the last monsoon, I visited these caves at least once a week, and often twice or more. Although the subject of my researches was the biology of bats, I took notes also of what I saw about Blanford's Rats.

Blanford's Rat, *Rattus blanfordi* (Thomas)



Two *R. blanfordi* in their haunt



At the nest, female and young.

Photos : A. Brosset

R. blanfordi appear in the Kanheri Caves immediately after the beginning of the monsoon. Before the rains, when I visited the caves, not one was visible. But, on the 18th of June 1960, 16 Blanford's Rats had taken up residence in different places. The majority remained there till the end of the monsoon in September. Two families remained up to the 13th November, after which all disappeared completely.

In June, I noticed 5 pairs and 6 isolated individuals. Two or three of the latter were half grown. Afterwards, we saw in other caves three more pairs. Most of them were in niches excavated in stone walls, but a few were just resting on the shoulders or the head of the Buddhas carved in the rock. The rats were naturally tame, and did not fear very much the approach of humans. One could observe, photograph, and even lightly touch them without prompting this amiable animal to bite or to escape. It was also noticeable that this species is not a repugnant mammal, as *R. norvegicus*. Its appearance and disposition helped my observations.

In the course of my visits in June and July, I had the opportunity to follow the life of a family, from the birth of the young ones to their dispersal. We made notes on the growth of the young ones and behaviour of the parents. These observations were continued in September and October, the animals having been marked—the marking was done on the tail with mercurochrome.

The synthesis of my notes on *R. blanfordi* could be placed as follows:

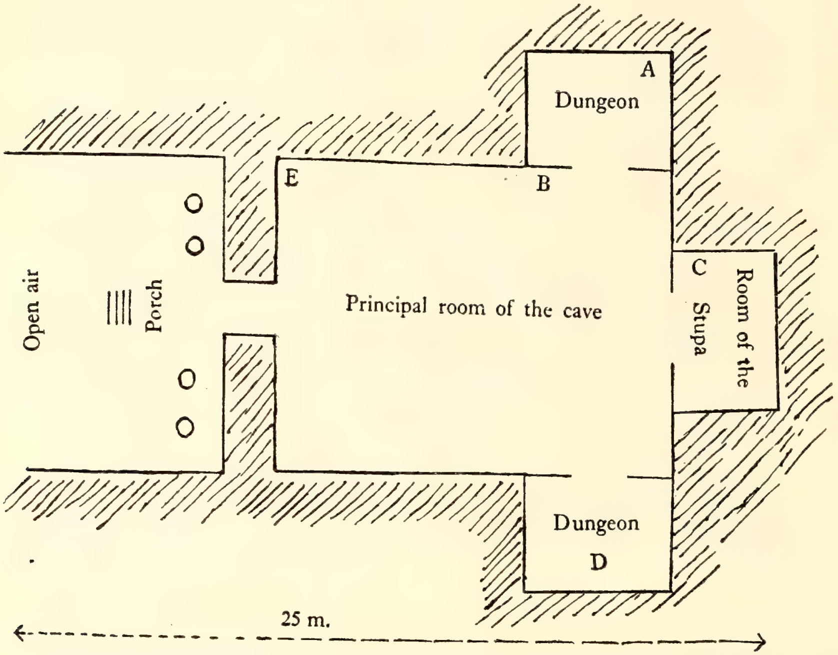
(1) Ecology (diurnal biotope)
(2) Social life (inter- and intra-specific associations)
(3) Reproduction (the nest and the young)

ECOLOGY

The caves are a seasonal haunt, inhabited specially during the monsoon. During the dry season these rodents probably live in crevices of rocks, under stones, and in hollows of trees.

The caves selected by the rats were situated in hilly country, far from human activity. The Kanheri Caves which are daily visited by a number of people during the dry seasons, are very quiet and deserted during the monsoon.

Blanford's Rats were always found in the darkest and most secluded parts of the caves, sometimes in crevices in rocks as in Bedsar, but most often in small niches in the walls. Seldom do they lie on the ground. Small dungeons adjacent to the principal caves are most often chosen as a haunt (see text-figure).



Plan of Buddhist cave with its fauna of vertebrates during the monsoon (Kanheri, 18th June 1960)

A : Nest of Blanford's Rat—1 female and 3 young ; B : Toad, *Bufo melanostictus,* moulting ; C : Place of male Blanford's Rat ; D : Haunt of 18 Bats *Megaderma spasma* ; E : Place of a pair of large geckos, *Hemidactylus maculatus.*

Blanford's Rat is a nocturnal animal, and leaves the caves a long time after sunset. During the day, it usually refuses to go into the open air, even if disturbed by man.

I had the opportunity to observe the start of a family for the nocturnal trip on the 20th of July after sunset. I believe that it was the first outing of the young. Thirty-five minutes after the beginning of the night, the three young ones appeared at the door of the cave. They made a very slow and careful exploration of the porch. After about ten minutes of hesitation, suddenly, they rushed into the open and disappeared in the tall grass of the hill.

About a quarter of an hour later, the parents appeared in their turn in the porch and left the cave.

On our next visit, three days later, the pair of adults were there. But the young ones definitely abandoned their parents.

SOCIAL LIFE

Blanford's Rat is a sociable species, although isolated individuals are not rare (6 cases observed). The group is a family association: a pair of adults with or without young.

During about 45 days after their birth, the young ones depend on the parents. In certain cases, as in Kanheri, they dispersed immediately after weaning. But in Bedsar three young about 2½ months old were still living with the parents.

The observations are in conformity with what we know of the social life of the other *Rattus* species associated with man, *R. rattus* and *R. norvegicus*. For both, the social group is a family one. If food is plenty, the young remain in the family group. If food is scarce they leave the native biotope after weaning.

The Buddhist caves of Bombay State give refuge not only to Blanford's Rats, but also to many other vertebrates, such as mice and rats of different species, squirrels, bats, geckos, toads, etc. One can notice that there is no inter-specific association amongst rodents in the cavities; the presence of other rats or mice excludes that of *R. blanfordi*. So, at the beginning of the rains, when a lot of different rodents took shelter in the Kanheri Caves, individuals of a single species were always seen in each cave. But Blanford's Rats tolerate very well bats and toads in their haunts. So, in several caves, I saw toads, *Bufo melanostictus*, in the immediate proximity of Blanford's Rats. These toads come here during the monsoon, for their moult, probably needing relatively dry air for this operation. It is strange to see the toad taking off his skin with the help of his legs and mouth, and gradually eating the removed skin. I observed such an individual very busy in this work, while in the same dungeon, a female Blanford's Rat was suckling her young.

The association of the rat with bats in the same caves is common. I saw species of bats, such as *Hipposideros galeritus*, *Taphozous melanopogon* and *kachhensis*, and *Megaderma lyra*, cohabiting with Blanford's Rat. In a cave at Kanheri a colony of the rare bat *Megaderma spasma* lived in good understanding with five *R. blanfordi*, two adults and three young. Curiously enough the *Megaderma* or False Vampire bats are known as eaters of small rodents. But, in the present case, these ferocious Chiroptera did not attack the rats, even the young ones during the first period of their life. Perhaps like many other raptors the bats have a zone of protection in the immediate vicinity of their haunt. In any case we can consider the association of rats with bats as a testimony of their mutual sympathy.

These associations are only phenomena of convergence, which bring together in the same biotope different mammals having the same ecological requirements.

REPRODUCTION

I was lucky enough to follow in good condition the reproduction of a couple, in June, in Kanheri Caves. The female was marked and had a second litter at the beginning of the autumn. I saw also two other cases of reproduction, in Bedsar and Kanheri Caves. I give the relevant particulars in the table below:

Bedsar	Kanheri : Pair No. 1		Kanheri : Pair No.2
	First Litter	Second Litter	
Young probably 2½ months old on 4th June 1960	Young 6-8 days old on 18th June 1960	Young about 50 days old on 13th November 1960	2 Young about 50 days old on 13th November 1960
Date of birth (estimated): about 20th March	Date of birth (estimated): 10th June	Date of birth (estimated): 1st October	Date of birth (estimated): 1st October

The observations are not very significant about the periodicity of reproduction. In fact, though we always saw young ones more or less grown amongst these rats, the greater number of pairs were without young ones, and nothing is known about reproduction in winter. It is a fact that reproduction in the well-known species *R. rattus* and *R. norvegicus* is primarily dependent on the quantity of food, and has no special season. Probably, the reproduction of *R. blanfordi* has no periodicity, and can take place at any time.

We saw in Kanheri Caves that 3½ months separated the second litter from the first. But this observation is perhaps also not significant, for in the species of the *Rattus* genus the frequency of the broods seems to be a function of the availability of food.

SIZE OF LITTER

We found as follows:

Bedsar	.. 3 young.
Kanheri:	
1st couple	.. 3 young (first litter)
	.. 2 young (second litter)
2nd couple	.. 2 young

The cousins of Blanford's Rat, *R. rattus* and *R. norvegicus,* have from 7 to 12 young, with an average of 8[1]. The number of my observations is not enough to give a definite idea of the litter-size of *R. blanfordi*. Nevertheless, it appears that this size would be extremely small for a rodent of the *Rattus* genus. As a compensation, juvenile mortality in *R. blanfordi* would be expected to be equally low. No loss by sickness or predators was noticed in the four cases observed.

THE NEST

Particulars of the nests observed are given below:

	Bedsar	Kanheri : Pair No. 1		Kanheri : Pair No 2
		First Nest	Second Nest	
Situation of the nest	In a deep crevice in a wall	In a corner of a dungeon (see plate)	In a niche excavated in the wall of a dungeon	In a niche excavated in the wall of a dungeon
Composition of the nest	No nest. The family lay on the barren rock.	Flat and rudimentary nest, of a few sticks, and pieces of cardboard and match-box	Nest made of small sticks and pieces of match-box	Nest made of sticks and dry leaves

Two remarks must be made. Firstly, the situation and the composition of the nest are variable. Secondly, the nest of *R. blanfordi* is completely different from those of the other *Rattus* species; in fact, *R. rattus* and *R. norvegicus* build a ball-shaped nest, fully furnished in the interior with hairs, whereas no hair is visible in the flat and primitive nest of *R. blanfordi.*

THE YOUNG, THEIR GROWTH, AND BEHAVIOUR

The growth is slow for a rat. The young ones seem unable to get independent of the parent before 45 days.

When we saw for the first time the young ones of Kanheri Caves, they were 6-8 days old. The body was covered with short and blackish fur. The white pencil of the tail was visible. The eyes were closed; they opened only about ten days later.

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[1] The editors have drawn my attention to the fact that of the seven species of *Mus* in Blanford's FAUNA : 405 which are now accepted in the genus *Rattus* and of which the number of mammae are recorded, two species have 10 to 12, one 10, three 8, and *blanfordi* only 6. I have subsequently examined one female with one young which had only 4 teats.

During the first month, the young are continuously under the mother, firmly fixed to her dugs. These dugs have a secondary utility, as an organ of fixation. It appears also that the young ones possess a special buccal reflex, which attaches them firmly to the dugs at the approach of danger. So the mother can escape with her young ones fixed under her belly. I saw several times at Kanheri the female climbing quickly on the vertical wall, up to the ceiling of the dungeon, with the three blind young ones hanging on to her dugs. After the end of the alarm the whole family returned to the nest.

Probably this method is regularly used by Blanford's Rat mother to carry her young ones to a safe place in case of predator-attack.

After about a month, the young ones were freely moving around the nest. At this time, the male which till then was living alone in an adjacent dungeon, came to join the rest of the family.

When the young were 45 days old, their size was a little more than half of the size of the adults. They left the native home at this time.

CONCLUSION

The social life of *R. blanfordi* seems similar to that of the well-known town-rats. But other aspects of its biology, as ecology and reproduction, are different.

In our epoch, when classification has ceased to be only a convenient system of grouping the species, and tries to give us a picture of the evolution of living beings, ecology, behaviour, and reproduction are important elements for the differentiation of species, genera, and families of animals. Perhaps one day, the systematists will put Blanford's Rat in a separate genus. It is certain that a psychological character, like the aptitude or inaptitude to associate with man, determines in a large scale the divergent evolution of the species belonging to the actual genus *Rattus*. If we conceive the classification not as a static structure, but as a dynamic representation of the history of the species, we must bear in mind this psychological character, so important for the future of these rodents.

Obituary

ARTHUR STANNARD VERNAY

Arthur Stannard Vernay, the distinguished traveller, naturalist, and explorer, and life member of the Society, died at the Rassin Clinic, Nassau, Bahamas, at the age of 83 on October 25th 1960. He is survived by his wife, Mrs. Marion Kelley Vernay whom he married in 1908.

Born in England in May 1877, he moved to New York as a young man, but retained his British nationality. In New York he founded the Vernay Galleries, dealing in antiques. He retired in 1941, handing the business over to his employees.

His first visit to India was in 1921, to stay with Ralph Morris, on the Billigirirangan Hills. Never before had Vernay seen game animals in their wild state, and he was very impressed. His experiences on this visit inspired the subsequent discussions he had with the late Col. J. C. Faunthorpe, then Commissioner of Lucknow, out of which came their joint offer to the American Museum of Natural History to collect Asiatic mammals for a projected new hall in the museum. Vernay financed the entire cost of the collections and of their transportation. The first Vernay-Faunthorpe Expedition in India was in 1922-23, and was quickly followed by five other expeditions in India, Burma, Siam, and Malaya on which the collections of mammals, birds, insects, reptiles, and botanical specimens for the Asiatic Hall were made.

In 1924 Vernay visited East Africa, and in 1925 he organized and led the Vernay Angolan Expedition, to Portuguese Angola, where he collected the Giant Sable group for the African Hall of the museum. In 1928 he was elected Vice-Patron of the Bombay Natural History Society for a grant which permitted a mammal and ornithological survey of SE. India. The report on the ornithological section of the survey by N. B. Kinnear and Hugh Whistler has formed for many years the basic work on the taxonomic status of the birds of peninsular India.

The Vernay-Hopwood Chindwin Expedition took place in 1935 and in the same year Vernay and Suydam Cutting visited Tibet at the invitation of the Dalai Lama. On many of the expeditions Vernay had personnel from the museum to assist in the preparation of the specimens for the museum groups. Two later expeditions to Africa were those to the Kalahari in 1930, and to Nyasaland in 1946, the last being his final major expedition. A fruitful expedition on the botanical plane was that of 1938 when Vernay, together with Cutting and G. K. Stanford, visited parts of north-eastern Burma, never before explored by a scientific group. Vernay became a trustee of the American Museum of Natural History in 1935, and held the title of Field Associate in the Department of Mammalogy at his death. He also made contributions of natural history specimens to the Field Museum, Chicago, and the Transvaal Museum.

After 1946 he became interested in Orchids, and he soon became one of the world's authorities on orchids, of which he had a very fine collection. He visited South America in his searches for orchids, and studied the Spanish language for this purpose. This was so typical of the man; whatever he took up he carried out with thoroughness and perfection.

He founded the Society for the Preservation of the Flamingo and saved from extinction the Flamingo of the Bahamas. As a result of his efforts, in co-operation with the National Audubon Society of Washington, a sanctuary was established for the Flamingo on the Island of Inagua—where they have greatly multiplied.

R.C.M.

Reviews

1. ATLAS DER VERBREITUNG PALAEARKTISCHER VÖGEL (=Atlas of Distribution of Palaearctic Birds). Edited by Erwin Stresemann (Berlin) and L. A. Portenko (Leningrad). Prepared by G. Eber, G. Mauersberger, L. A. Portenko, and J. Szijj. Part I, containing 20 distributional and 4 migration maps in folder, (*c.* 34×27 cm.). Published by Akademie-Verlag, Berlin, 1960. Price 28 DM.

The geographical distribution of birds in the Palaearctic Region is on the whole better documented than in any other part of the world excepting perhaps N. America, witness the latest critical work of Vaurie[1] reviewed in this journal Vol. 56, pp. 307-9.

By virtue of the very lavishness of the data, however, the necessity had long been realized for organizing them in a graphic form which would show a bird's overall breeding distribution at a glance, without the tedious and time-consuming labour of having to wade through and collate the widely scattered multilingual literature in each case. The published locality records, moreover, were of specimens collected or observations made not necessarily of breeding birds only, and therefore needing careful scrutiny and sifting. It was clearly a task for co-operative teamwork by specialists imbued with a spirit of dedication and unlimited patience. Happily for ornithology, such a team has materialized, and this ATLAS is the fruit of its united labours and erudition.

The 20 distributional maps contained in this first part, besides 4 of migration, are mostly the handiwork of G. Mauersberger. The explanatory text by the editors, which accompanies each map, is arranged under the following heads:

Relationship: The nearest species or group of species to the one under consideration is indicated. For example, under *Emberiza melanocephala* is mentioned its eastern neighbour *E. icterica* and that both have obviously sprung from the same stock due to prolonged geographical separation, and that they hybridize in a small overlapping area near the Caspian Sea.

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[1] Charles Vaurie (1959) : THE BIRDS OF THE PALAEARCTIC FAUNA, London.

Arrangement (Gliederung) of races, etc: Remarks on geographical races, if any recognized.

Distribution: Giving references to detailed distribution maps, if any published in regional literature, and remarks.

Ecology: Indicating the types of summer and winter habitats.

Migration and Wandering: Routes and destinations as deduced from specimens and published data, amplified by records of ring recoveries where available.

The authenticated peripheral localities which, joined up, delineate the bird's summer (breeding) range are pinpointed on the map by means of solid triangles (numbered). A list of these is given under each map with symbols (A, b, etc.) indicating the evidence upon which such point has been accepted from the literature, i.e. where a bird has been reliably recorded as breeding, or with enlarged gonads, or where a nest or fledgling has been found, and so on. A list of publications from which such data have been extracted follows localities and symbols under each map.

The hall-mark of authority on all the above is set by the invincible combination of the editors, Erwin Stresemann and L. A. Portenko. The latter's expert knowledge of bird distribution in the eastern Palaearctic Region, in the territories of the U.S.S.R., has proved invaluable.

In his Foreword Prof. Stresemann points out that on a consideration of the 800 odd palaearctic birds it was felt that distribution maps would be needed for at least 200 species, mostly passerine and woodpecker. Thus, at the present rate, the work will need 10 parts to complete. No date-line is set for the succeeding parts. The maps, as in the present part, will follow no particular sequence of classification since their preparation is based on other considerations. They are printed on unnumbered loose sheets enclosed in a folder so that they can later be bound in the taxonomic order to be indicated in the final part. This last will also contain a concluding chapter discussing the theoretical implications arising from a critical study of the maps and the explanatory text.

This is a magnificent and much-needed though truly formidable undertaking. Prof. Stresemann is to be congratulated upon the realization of a dream which, in spite of interruptions and disappointments, he has steadfastly cherished for over 25 years and finally brought to near fruition with such able helpers and with the far-sighted and munificent co-operation of the Deutsche Akademie der Wissenschaft zu Berlin.

The succeeding parts of this indispensable work will be eagerly awaited.

S.A.

2. THE BIRDS OF BORNEO. By Bertram E. Smythies. Pp. 562 (15.5 × 23.5 cm.). With 50 plates in colour by Comdr. A. M. Hughes, 49 photographic plates (2 in colour), and special chapters by Tom Harrisson, Lord Medway, and J. D. Freeman. Edinburgh and London, 1960. Oliver and Boyd. Price £4 4*s*. net.

Borneo is the third largest island in the world, after Greenland and New Guinea, and five times the size of England and Wales. More than 80% of it is covered with luxuriant tropical forest. It is sparsely inhabited by primitive tribes, poor in communications, and little known ornithologically, especially the southern parts known as Indonesian Borneo. It is true that several large ornithological collections have been made in the island during the 19th and 20th centuries and, in so far as the mere listing of species goes, both the montane and lowland birds have been fairly well covered. Little field work has, however, been done on their habits and ecology, and recurring statements under various species such as 'Not known' or 'Very little known' only serve to emphasize the truth.

Therefore, for the would-be field student of Borneo's birds, and for bird-watching visitors to the island in general, it was essential that all that was known about them should be collated and condensed in a convenient form out of the many scattered scientific publications in different European languages, so that the amateur could get a proper idea of what was known about the birds and what was not known. Considering the richness of the avifauna and the exotic appearance of many forms peculiar to the island and to that zoogeographical region in general, good coloured illustrations were indispensable for field recognition.

A fortuitous and happy combination of circumstances has made such an extremely useful book as this possible: Tom Harrisson, the versatile and dynamic curator of the Sarawak Museum, as the moving force; Bertram Smythies noted for his BIRDS OF BURMA as author; Commander A. M. Hughes, who made his debut in that publication as a bird artist of unusual merit, as illustrator; and last but not least Loke Wan Tho, the widely reputed patron of ornithology and bird photographer of Singapore, as financier. With his habitual generosity Mr. Loke financed, almost entirely, not only the 4-year Sarawak-wide field collecting of birds, but also the painting of the illustrations and their 4-colour reproduction as well.

The total number of species dealt with is 554 (including 5 strays) of which 396 are resident and 158 migratory. Enviably enough almost every one of these is illustrated in colour. The 29 monochrome plates of birds are from superb photographs by Loke Wan Tho, F. G. H. Allen, and B. D. Molesworth, excellently reproduced. With such eloquence in illustration it has been possible to limit verbal descriptions to the minimum, and they mainly complement the pictures. In the systematic list the descriptions start with a general account of the Family followed by individual species numbered according to the same author's 'Annotated Checklist of the Birds of Borneo' published in *The Sarawak Museum Journal* in June 1957. Since the book is meant chiefly for the non-specialist, many of the details and references pertaining to taxonomy, distribution, etc., given in the Checklist are here omitted.

The paragraphs under each species, for most of which local names are also given, cover Status and General Distribution; Description; Habits; Nest and Eggs; and Races occurring in Borneo. Where several species of a group of birds occur, e.g. Sunbirds, Spiderhunters, Flycatchers, etc., workmanlike keys for diagnosis are provided.

Chapters 4, 6, and 7 entitled respectively 'Birds and Men in Borneo', 'Iban Augury', and 'A Note on the Gawai Kenyalang, or Hornbill Ritual of the Iban of Sarawak' contributed by Tom Harrisson and J. D. Freeman deal with the place birds occupy in the beliefs, superstitions, folklore, and domestic economy of the indigenous inhabitants and are of great ethnological interest. Chapter 5 on 'Cave Swiftlets' by Lord Medway, which is more germaine in the context of current Bornean avifauna, gives a very good account of the ecology, breeding biology, and economic aspects of the several species of Edible-nest Swiftlets (genus *Collocalia*) that inhabit the island's caves.

Appendixes on the history of Bornean ornithology, and a full bibliography of publications on Bornean birds follow; there is a folding sketch map of Borneo inside the back cover.

The physical bulkiness of the book—it contains 660 pages including the plates and weighs 1.623 kg.—obviously makes it inconvenient for use as an accompanying field guide. Considering the wealth of the material to be treated, this sacrifice of handiness was perhaps unavoidable. The author and all concerned in the publication deserve high compliment upon the production of a much needed and excellent handbook.

S.A.

3. BIRDS IN MY INDIAN GARDEN. By Malcolm Macdonald. Pp. 192 (32.5 × 23 cm.). With coloured frontispiece and 98 monochrome photographs by Christina Loke. London 1960. Jonathan Cape. Price 45*s*.

During his three years or so as British High Commissioner in India, Mr. Malcolm Macdonald lived at No. 2 King George's Avenue, a pleasant and comparatively quiet locality in the heart of New Delhi. This 3-acre plot contained a charming garden comprising spacious lawns, flower beds, jungly shrubbery, and a sprinkling of old trees with gnarled trunks mainly along its boundaries. This is the garden of the title. Whenever at his headquarters, it was part of Mr. Macdonald's daily regimen to rise early and stroll about his garden between 6 and 8 a.m. with binoculars hung round his neck, and take stock of the comings and goings and other domestic occurrences among the bird inhabitants of his estate and its environs. This early morning bird watching was occasionally supplemented during any lucid intervals that could be snatched between weighty official responsibilities and such other inescapable diplomatic preoccupations as cocktail parties, and welcoming and god-speeding an endless succession of international V.I.Ps. All he espied was meticulously jotted down, and by the end of his stay in Delhi a veritable stack of note-books had accumulated. These notes, judiciously distilled, form the basis of this very attractive volume. For such as are constantly bemoaning lack of time and opportunity for bird watching owing to mundane preoccupations, the book should come as an eye-opener: it demonstrates what may be achieved with sustained enthusiasm and organized effort, notwithstanding.

Mr. Macdonald was especially fortunate in discovering Christina Loke as his photographic collaborator. Many of her photographs illustrating the book—carefully chosen from amongst a formidable array—are certainly the finest portraits of Indian birds in existence. It must be remembered, moreover, that most of them were made under conditions of great physical discomfort from the cramped interior of a hide in the sizzling heat of a Delhi summer. They reflect the highest credit, not only on the aesthetic sense but also on the dedication of the photographer.

In his treatment of the subject the author divides up the year seasonally, chronicling the most important bird species and their activities in each month or season. The special chapters on Green Parakeets, the Coppersmith, Mynas, White-eyes, Crows and Koels, and Ashy Wren-Warblers contain many shrewd observations of great interest and permanent value, which have not been recorded by previous observers, e.g. the role of the sexes in site selection, nest-building, incubation, and feeding the young, as well as building techniques, and so on. The total number of different birds recorded in and from this garden was 136, including 30 species which actually nested within its limits. The descriptions of the social behaviour of the species towards one another, their competition for nest sites, their nesting successes and failures, and their family lives are pleasantly, and often amusingly, written. They convey to the reader some of the enjoyment the author himself so obviouly derived from his watching.

The account suggesting the communal nesting of Jungle Babblers —i.e. of more than one pair actively building a single nest, and collectively feeding the nestlings—is of special interest, since this state of affairs among this sociable group was long suspected before and has been amply corroborated since. The very full description on pages 112-113 of a Honey Buzzard tackling a honeycomb within a tree-hole is the first detailed eye-witness account I have seen of the process.

A useful index at the end gives a list of all the birds recorded in the book together with their Hindi and scientific names, with an asterisk against those that nested in the garden. The record will serve as an authentic standard for comparison 'forty years on' when the present breakneck speed of development in Delhi will have altered the character both of the environment and its avifauna altogether.

Both the author and the photographer deserve congratulation upon their achievement in producing this singularly attractive volume which is sure to be widely acclaimed. Considering the high quality of the production and the large number of excellent plates, the price of 45 shillings is by no means unreasonable. The only criticism I have is that the format of the book is too large for convenient handling and for the 'syncopated' modern homes in which it will mostly have to dwell!

S.A.

4. PLANT MARVELS IN MINIATURE: A PHOTOGRAPHIC STUDY. By C. Postma. 173 pp. (32.5×25 cm.). 77 photographic plates. London, 1960. George Harrap & Co. Ltd. Price 45*s*. net.

This collection of photographs, of magnifications varying from ×2.5 to ×3300, each accompanied by a short explanatory note, gives the reader glimpses into the structure and development of plants, and presents for his admiration and wonder the beauty of plant life in miniature. The photographs are grouped in series illustrative of different aspects of the subject and, with a little effort to understand the text, will be found very informative. The illustrations, which are of superlative quality, will be of interest to the student of botany.

D.E.R.

5. SERENGETI SHALL NOT DIE. By Bernhard and Michael Grzimek. Translated from the German by E. L. and D. Rewald. Pp. 344 (23×16 cm.). Numerous coloured and black-and-white photographs and 3 maps. London, 1960. Hamish Hamilton Ltd. Price 30*s*.

There is a sad tale connected with this book. Considering that the continued existence of the famous Serengeti National Park in Tanganyika was threatened by a proposal for revising its boundary and reducing its area, Bernhard Grzimek, Director of the Frankfurt Zoo, and his son Michael, aged about 23 years, determined by a study of the animals in the Park to satisfy the Government as to the disastrous nature of the proposed change, and at the same time to make a movie film of the Park and its animals which would interest a wide public and make them aware of the danger which threatened. Two problems which they set themselves had to be solved from the air. So they learnt to fly, and set out for far-away Tanganyika on their first independent flight in a newly-acquired aeroplane, which they affectionately called the 'duck'.

The first problem was the population of big animals in the Park. Census by photography was not practicable as photographs would have to be shot at close range for distinguishing the different animals appearing in them, and the cost of the 50,000 photographs necessary would have been prohibitive. There was nothing for it, therefore, but to fly at heights varying from 150 to 300 feet (*c.* 45 to 90 m.)

above the ground and actually count the animals in strips of about 500 yards (*c.* 460 m.) width covering the whole Park. Michael piloted the 'duck' while the counting was done by his father assisted by two game wardens, who had agreed to join in the work after each of them had been insured for £10,000. By gradual degrees the faculty was cultivated of counting the animals in groups of a dozen or more. Even so, the census was a feat of mental arithmetic and memory as the figures could be noted only at the end of each flight, and the animals belonged to about twenty different species and the flights at times lasted as much as three hours. The census established the number of large animals in the Park as being about 370,000.

The second problem concerned the seasonal migration of the animals: was it confined to the proposed new area as the promoters of the scheme believed or did it extend beyond the new border and require a larger area? This problem necessitated the marking of individual animals. A first attempt was made to catch zebras by chasing them by motor-car and when an animal was sufficiently exhausted passing over its head a noose at the end of a pole. The operator of the noose was perched precariously on the bonnet of the car and, in an accident which occurred at quite an early stage, Michael got a wooden splinter into his neck and nearly died. Fortunately, his father was able to fly him to Musoma, borrow a car near the landing ground there, and take him to a hospital where a competent Indian doctor removed the splinter. Next day father and son were back at the scene of their labours, and within a week they were chasing zebras in the Ngorongoro crater. Much later the method of capture by motor-car chase was improved, capture being made by catching hold of the animal by the root of the tail! In between, the Grzimeks experimented with a much-advertized 'miracle gun'. The hypodermic bullets supplied for the gun were found unsuitable for use in a pursuing car, and the Grzimeks had to work out their own hypodermic missile, and then by patient experiments repeated separately for each species of animal to work out the correct dosages.

And when all this was over and the animals were proved to move beyond the new limits proposed, the reasons for the migration had to be found out, in order to meet the argument that if the animals were confined to the new limits by suitable fencing they would adapt themselves to it and continue to flourish. This involved further low-flying, as much as 30 to 60 feet (*c.* 9 to 18 m.) above the ground, and frequent landings to collect samples of soil and fodder plants.

In the end they succeeded in collecting evidence to support their contention that the migration routes were determined by necessity, and that the soil in the new area proposed could not grow the fodder plants required by the animals.

Then, when the work was complete and the book was ready to be written, a laconic message reached Bernhard Grzimek in his hut in the Ngorongoro crater: 'I am sorry to tell you that Michael has crashed in the aeroplane and been killed. He is lying at my house.' So, although the names of both the father and the son appear as co-authors, the book is written by the father alone.

In the course of telling us about what he and his son did at Serengeti, Dr. Grzimek tells us about many other things. My review has already become unduly long, and I hope that what I have said will induce readers to acquaint themselves at first hand with what Dr. Grzimek has to say and to see for themselves the many superb photographs with which the book is illustrated.

There is one thing however which I cannot refrain from quoting:

> 'I constantly run across Germans and Englishmen who declare they can no longer bear to look at black faces. . . . I am not a a politician but a biologist and can only speak as such when discussing the black and white question. . . . What we have found is that all people and 'races' have about the same proportion of criminals and murderers, of brilliant men and idiots. . . . Hitler's *Mein Kampf* stated that it was 'against Nature' for black and white people to intermarry. . . . This, of course, is nothing but ignorant nonsense. . . . There is only one human race and Mongolians, Caucasians and Negroes are merely different types within it. If they intermarry they do not produce hybrids but intermediary forms. . . . Animal breeders know that the children of a cross between two pure, and therefore inbred, types of poultry are larger and healthier, than their parent; they show 'hybrid vigour'. The interbreeding of human types should have the same result. . . . For me a negro is an equal and a brother.'

Coming from a member of a nation so recently dominated by leaders who preached the doctrine of Nordic superiority, these are brave and memorable words. One hopes that they typify the spirit of the new Germany.

D.E.R.

6. THE COUNTRYMAN NATURE BOOK: AN ANTHOLOGY FROM THE COUNTRYMAN. Edited by Richard Fitter. Pp. 134 (22×15 cm.). 38 photographic plates and numerous drawings, Leicester, 1960. Brockhampton Press. Price 15*s*.

This collection of nature notes from *The Countryman* contains much to interest and amuse the nature lover, and has some beautiful photographs. Of particular interest are an eye-witness account of a mongoose-cobra fight, from start to finish a tense half-hour, and a description accompanied by a photograph of the emergence of ichneumon fly grubs from a parasitized butterfly caterpillar. I would also mention photographs of the mechanism by which the Salvia flower deposits its pollen on visiting bees. Some instances of animal intelligence and behaviour related here are difficult to believe but, the more one observes living creatures, the more one realises the wisdom of keeping an open mind.

D.E.R.

Miscellaneous Notes

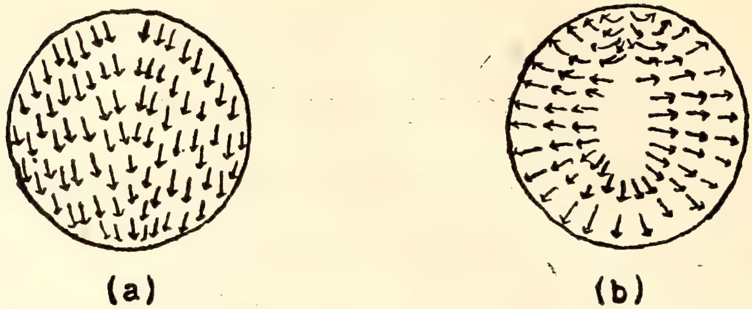
1. 'SCALP' OF THE ABOMINABLE SNOWMAN

(*With three text-figures*)

In the *Journal* (Vol. 52, pp. 594-598) we reviewed the evidence for the existence of the *yeti* or Abominable Snowman and referred in particular to the 'scalp' at the Pangboche Monastery in north Nepal. A hair from the 'scalp' was reported upon by Dr. L. A. Hausman of New Jersey, U.S.A. and, though it was not possible to match it with any other animal hair immediately available, Dr. Hausman said that it was artificially coloured and that the photograph of the 'scalp' suggested that it was a moulded and sewed artifact.

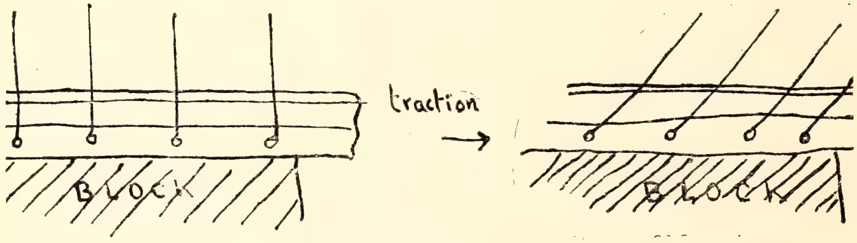
Subsequently, Dr. Bernard Heuvelmans in ON THE TRACK OF UNKNOWN ANIMALS (London, 1958) considered the evidence at length; he came to the conclusion that the *yeti* is a giant biped anthropoid hitherto unknown to science and named it *Dinanthropoides nivalis*. Regarding the 'scalp' he stated that the hair tracks on it were arranged in a pattern which made it impossible that it could have been obtained from any known quadruped. A second specimen from the Khumjung lamasery, not far away, was found to be similar, while a third one discovered at Namche bazar appeared to be a fake.

Late in 1960 Sir Edmund Hillary, the leader of another expedition into the Everest area in search of the Snowman, was able to borrow the 'scalp' at Khumjung and took it to Dr. Heuvelmans for his examination. Dr. Heuvelmans in a recent letter to the Society communicates a change of opinion. His letter will be easier to understand if we give the reasons for his former opinion, namely that 'on a hoofed mammal's back the hairs all point towards the hindquarters, parallel to the median line in what is technically called 'the primitive cranio-caudal line' [Text-fig. 1 (*a*)], whereas 'the hairs in the alleged snowman scalps begin parallel to the median line in what is thought to be the forehead, soon turn at right angles to it and remain at an angle until the nape of the neck where they return to this original parallel direction' [Text-fig. 1 (*b*)]. Dr. Heuvelmans writes: 'When the so-called "scalp" was shown to me in Paris by Sir Edmund Hillary I was struck by the appearance of



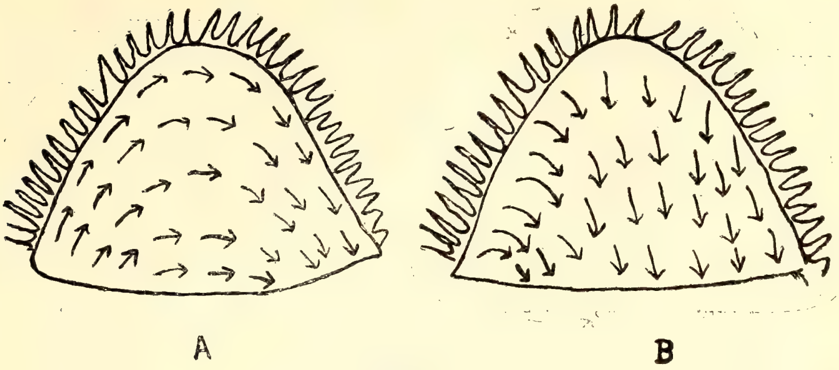
Text-fig. 1. The arrangement of hair-tracts on (a) a quadruped's back ; (b) the supposed snowman's scalp.

the fur and especially of the median erected crest of hairs, which reminded me of the mane of a Serow. But I could not understand how this relic could have been made from the skin of the neck or shoulder of the Serow. I explained my doubts to my friend and fellow zoologist Ivan T. Sanderson from New York, who demonstrated that when a piece of skin is exaggeratedly stretched on a milliner's block there occurs a sort of shift of the various layers of the skin, which modifies completely the original inclination of the hairs. The lower layer having a tendency to adhere to the block, the whole skin is distorted and the hairs become inclined towards the direction of the traction (Text-fig. 2). So the original hair-tracks (Text-fig. 3, A) become a pattern, which is exactly the one found on the head of a tall primate (Text-fig. 3, B).



Text-fig. 2

'When I understood this it remained to be seen whether my first intuition about the identity of the animal whose skin had been used to make the "scalp" was correct. There was no skin of a southern Serow in the Paris Museum, but I found one in the Brussels Institute, not exactly from the Nepalese subspecies (*Capricornis sumatrensis thar* Hodgson) but from the same species, the original Sumatran one. I checked the hairs of this Serow against the hairs of the Khumjung



Text-fig. 3

scalp (given to me by Sir Edmund) and against the hairs of the Pangboche scalp I already had. They are identical. It should be stressed that Professor Teizo Ogawa (Dept. of Anatomy, University of Tokyo) who studied microscopically the hairs from the various scalps from Pangboche, Khumjung, and Namche bazar, has demonstrated that they all come from the same kind of animal.'

BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD,
BOMBAY 6,
March 8, 1961.

EDITORS

2. 'OCCURRENCE OF THE SEA COW, *HALICORE DUGONG* (ERXL.), OFF THE SAURASHTRA COAST'[1]

A recent note by Mani (1960) which appeared under the above title calls for some comments.

1. The occurrence of a dead and floating dugong in the sea noticed near Kalyan lighthouse on 17 July 1959 is a rare sight indeed, and to my knowledge this appears to be the first such record. The natural tendency of many of the marine mammals is to sink when they are killed and that such was not the case with the above specimen, in spite of its relative freshness, is interesting. The cause of death, whether due to injury or excessive infestation from intestinal

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[1] Published with the permission of the Chief Research Officer, Central Marine Fisheries Research Station, Mandapam Camp.

parasites or some natural cause is unknown. The sex[1] of this animal is not given, but fortunately as the head appears to have been preserved, this could be easily verified.

2. The author mentions a second specimen, this time a female caught from the same place on 30 July 1959 measuring[2] 13′ 4″ (4.06 metres); if this length is correct, it is a record as there is up to now no authentic report of any dugong of this gigantic size. The method used in measuring is not given, but if it represents a straight line measurement from the anterior end of the muzzle (snout) to the fork of the caudal flukes, the size is exceptionally large. It is a pity that, in spite of the animal being 'retrieved intact', a photograph and other body measurements of the animal were not taken. In a way, the sex of the animal is also interesting. The general tendency, I find, is for the male dugong to attain larger proportions as is the case with some marine mammals and, if this be so, should we expect some day to find a still larger male? The average size of the Indian dugong is about 2.5 metres and it is known to attain about 3.5 metres. The Red Sea dugong which Gohar (1957) considers to be subspecifically distinct [*D. d. tabernaculi* (Rüppell)] is said not to exceed 3.15 metres.

3. The proximity and identical locations of the two occurrences are noteworthy. Information as to whether dugongs are seasonal visitors to the Saurashtra Coast will be of interest.

4. The author remarks that 'This relation of the sea lions and seals is reputed to use its forelimbs as hands for conveying food to the mouth . . .' It may be said in this connection that the dugongs (Sirenia) are as distinct from the amphibious Pinnipedia (Carnivora) as the elephant is from the lion, but the dugongs and the Pinnipedia (sea lions, seals, etc.) evince some convergent resemblance on account of the aquatic mode of life that they share. I have never during my observations on the captive dugongs kept at the Central Marine Fisheries Research Station, Mandapam Camp, seen them using the flippers to convey food to the mouth, although in addition to their natatory function they are used for other purposes, such as: for supporting the anterior part of the body while resting at the bottom, with the distal part of the flippers slightly flexed outwards; for moving a few paces forwards or backwards on the bottom, with the flippers in the same attitude as described above but used alternatively,

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[1] The skull received by the Society from Mr. Mani is that of a male, and since he describes the second dugong as a female, must be the skull of the first.—EDS.

[2] We are informed by Mr. Mani that the animal was placed alongside the wall of a cold storage room and the tips of the snout and the caudal flukes marked off on the wall and measured by him personally.—EDS.

the movement itself being primarily governed by the action of the tail flukes; and for making short forward or backward 'glides' in mid-water, with both flippers used simultaneously. When beached or when the water in the tank is kept low for cleaning, the animal may flex back the anterior part of its body as though drawing itself up on its flippers and make ineffective attempts to lunge or lurch forward at the same time using both flippers simultaneously in a few antero-posterior thrusts, all the while beating the tail strongly up and down. Often such violent action results in the animal turning supine and when it rolls on to one side the flippers are used to right itself to its normal position. Underwater, occasionally one of the flippers may be flexed forwards in a rotatory movement to brush the chin. However, these are only secondary actions, for the primary mode of locomotion in the dugong as in the cetaceans may be termed 'tail propulsion', where the swimming movements are effected by the up-and-down movements of the posterior part of the body and the horizontally-placed tail flukes.

5. According to Ellerman & Scott (1951), the correct nomenclature of the Indian dugong should be *Dugong dugon* (Müller).

6. Incidentally, newspaper reports[1] dated 23 July 1959 referred to the capture of a dugong on the Saurashtra coast as follows: 'FISH RESEMBLING MAN CAUGHT: . . . Townspeople of Jamnagar and the surrounding areas have been flocking to the near-by port of Rozi, to view with amazement a unique catch of a 400-pound, 16-foot-long fish, whose head, features and chest formation are said to resemble a human being. . . .'; 'A fisherman, Juma Abdullah, of Bedi Port, caught the giant fish in his net while out at sea.' 'The entire population of the village of Bedi and large numbers of persons from Jamnagar have been thronging the Rozi sea coast to view the strange catch—the first of its kind made in these waters. . . .' No doubt, these reports refer to the first specimen mentioned by Mani (1960). The length of 16 feet would appear to be an exaggeration, while the weight of 400 lb. will be more correct for a dugong measuring about 2 metres. A 2.47-metre-long specimen weighed here scaled 260 kg. (565 lb.).

7. There is an editorial comment at the end of the note to the effect that 'These Saurashtra specimens extend the *recorded distribution* of the Dugong in India to north of the 15th parallel. 'Bedi (Jamnagar) is *c.* 22° 30′ N.' (*italics mine*). While these two are

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[1] NAFEN report in the *Pioneer*, Lucknow, and other daily papers.

definite records, the late Dr. S. T. Moses's statement, 'The dugong is said to have been caught in a *bush vada* (a type of fence net) near Sachana in 1877', bears repeating (Moses, 1942).

8. For a recent informative account on the Indian dugong, reference may be made to the article by Jones (1959). It might interest all animal lovers in general and those interested in the conservation of marine life in particular that steps are being taken by the Marine Biological Association of India for the conservation of this animal. It is earnestly hoped that the Dugong Research and Conservation Fund, started under the auspices of the Association, will receive support from all quarters.

Central Marine Fisheries Research Station,
Mandapam Camp,
S. India,
September 22, 1960.

E. G. SILAS

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3. 'THE HISPID HARE, *CAPROLAGUS HISPIDUS* (PEARSON)'

With reference to your interesting note in the *Journal* for August 1960 (Vol. 57, No. 2, p. 400) the following may be worth recording.

The Hispid Hare was not uncommon in parts of the Goalpara Forest Division, Assam, when I served there from 1907 to 1911. They lived mainly in Ulu-grass (*Imperata* sp.) i.e. thatch 3 or 4 ft. high which at that time covered considerable stretches of the drier grass-lands. We occasionally shot one when out with a line of elephants and thought them quite good eating. Unfortunately, as we then had no idea of their impending scarcity, I never kept a skin or skull, and though I remember making a water-colour sketch this is long since lost. My recollection is of an animal very like your photograph of the Van Ingen specimen. The ears, though short and normally laid back and held together, could certainly not be described as 'not projecting beyond the fur'. I find two old pencil notes in my copy of Blanford reading: 'body more the shape of a guinea-pig than a hare' and 'some say he is not good eating but I have found him all right'.

My Divisional Forest Officer, the late T. H. Monteath, told me that nobody knew whether the young were born blind and naked in burrows or fully developed in the open and urged me to try to find out as he had never found a burrow himself. I searched likely spots after a grass fire but never found a burrow though I saw a few shallow 'scrapes', such as rabbits make, which *might* have been due to hispid hare. When, in 1911, I was transferred from Goalpara to Buxa Division (now in W. Bengal), Monteath, who had been in Buxa earlier, told me I should find the hispid hare there but I saw very few—only one that I can be positive about. In my early days in Buxa I fairly often saw movements in Ulu-grass which I had come to associate with groups either of hispid hare or of pigmy hog, but by that time we realized that both these species were becoming rare for I remember being asked to try to get a live pair of either for the Calcutta zoo.

Until I read your article I had not realized how rare the hispid hare had become in India. Is it known to occur elsewhere? I ask because, while a prisoner in Singapore, a friend told me of a hare or rabbit that he had seen in southern Thailand which, because it lived in parties in *kajang* (the Malay equivalent of Ulu-grass) sounded more like the hispid than the Indian hare. Unfortunately I have lost touch with my informant and cannot even remember his name.

THE SANDS HOUSE,
SOUTH NEWINGTON,
BANBURY, OXON, ENGLAND,
February 1, 1961.

E. O. SHEBBEARE

4. PARENTAL CO-OPERATION IN THE FEEDING OF NESTLINGS IN THE INDIAN ROBIN [*SAXICOLOIDES FULICATA* (LINN.)]

A pair of Indian Robins [*Saxicoloides fulicata* (Linn.)] built their nest in my room, between two toffee tins placed on a narrow wall-shelf at a height of about 6 ft. (*c.* 2 m.). The nest was ready on the 2nd of July 1960; the first egg was seen on the morning of the 3rd, the second and the third, which completed the clutch, on the 4th and 5th respectively. The first egg hatched on the 15th and the other two nestlings were seen on the 16th morning.

The behaviour of the parents in the feeding of their nestlings was observed from a hide built at a distance of about 4 ft. (*c.* 1 m.) from the nest. The birds were seen to fetch food by turns and feed the nestlings. Ordinarily, when the male came with food, the female would be away. Between his visits the female would sit for some time in the nest covering the nestlings. If the male arrived with food during that time, she would hurriedly leave the nest to fetch food; the male would then feed the nestlings. At times it would so happen that, when the male arrived with food, the female would continue sitting. In this situation the female would stretch her head towards the male and he would gently put the food into her beak. He would then withdraw a little and, standing by, watch his mate feed the nestlings with the same food. As soon as this feeding was done he would quit to fetch the next feed, while she remained in the nest for some time. This sequence of events was photographed. Such behaviour was more frequently exhibited in the first few days after hatching and more so in the mornings. With the progressive growth of feathers of the nestlings this behaviour became rarer, and I did not see it after the 20th by which time the feathers were more or less sufficiently grown to give them warmth.

This is an interesting case of parental co-operation. By this means the female could rest a while by skipping one of her own turns of fetching food. Also, the nestlings were not left alone without warmth for long. The male seems to realise at once what his mate expects him to do and responds readily; the initiative in this particular behaviour rests with the female.

Division of Avian Biology,
Department of Zoology,
M.S. University, Baroda 2,
January 30, 1961.

J. C. GEORGE

5. FURTHER NOTES ON THE WINTERING OF THE FOREST WAGTAIL, *MOTACILLA INDICA* (GMELIN) IN INDIA

Recently in *Journal* **57** : 220 I recorded seeing 7 to 8 Forest Wagtails, *Motacilla indica* (Gmelin), in the grounds of the Madras Christian College, Tambaram, from 19th September to 7th October presumably on their way south and west.

This year three to six birds were seen every day from 11th to 28th April in the same locality and it would appear that they follow the same route in both directions. They had not yet broken up into pairs nor was any change in their behaviour noticed. This appears to be the first record of this bird in peninsular India on the return migration and it would be interesting to try and obtain more details of their movements.

Department of Zoology,
University of Connecticut,
Storrs, Conn., U.S.A.,
October 22, 1960.

P. J. SANJEEVA RAJ

6. THE NESTING HABITS OF THE EASTERN RACE OF FINN'S BAYA, *PLOCEUS MEGARHYNCHUS SÁLIMALII* ABDULALI

In the last *Journal* Vol. **57** (3) : 659-662 I separated Finn's Baya from the eastern end of its range as *Ploceus megarhynchus sálimalii* and drew attention to O'Donel's records from the Bhutan Duars which stated that the nests were untidy balls of grass strips . . . loosely and carelessly put together with no lining and fixed to the stems of grass. I referred to the nesting specimens of the eastern race taken by Dr. Koelz from near Goalpara in Assam and, in the absence of any information regarding the type of nest built by them, suggested that they did not nest in trees like the typical race in the west, but in grass.

I have now been able to contact Dr. Koelz and, in a reply just received, he says: 'My birds were nesting in trees in a grass area. The trees as I recall were small *Erythrina* more or less stunted, some 15 feet (*c*. 4.5 m.) high. There was a scattered clump of them, may be a dozen trees. The nests were the untidy type you describe not the neatly woven tube-entranced nests of the weaver birds. Furthermore, the breeding birds caught my attention from afar by their

Passer domesticus-like chatter. I don't know where my notes are or I could give you information on the number of nests etc. . . .'

Though it does seem unlikely that O'Donel was only referring to the 'doodling' nests in grass described by Drs. Sálim Ali & J. H. Crook (*J. Bombay nat. Hist. Soc.* **56** : 463) and overlooked colonies in trees, it would appear from Dr. Koelz's report that the eastern birds also build in trees.

BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD,
BOMBAY 6,
February 28, 1961.

HUMAYUN ABDULALI

7. THE EASTERN STEPPE EAGLE [*AQUILA NIPALENSIS NIPALENSIS* (HODGSON)] ON THE SOUTH COL OF EVEREST

Members of the Indian Everest Expedition noticed three specimens of large birds of prey, lying dead on the South Col at a height of nearly 26,000 ft. (7925 m.) on 23rd May 1960. One of these was brought down and later identified as the Steppe Eagle [*Aquila nipalensis nipalensis* (Hodgson)].

This species is a migrant between India and central Asia and it is interesting to note that some of the birds migrate over the South Col which is indeed one of the most difficult areas to cross. It appears that the birds were overcome by weather conditions during their spring migration to the northern range of their distribution. The South Col is perhaps one of the regular migratory routes of this species as Tenzing in his biography mentions seeing a dead eagle, possibly of this species, on the South Col during the autumn expedition of the Swiss in 1952.

The measurements of the specimen collected by the Expedition are: Wing 585 mm.; tail 290 mm.; culmen 55 mm.; tarsus 98 mm.; hind claw 35 mm.

HIMALAYAN MOUNTAINEERING INSTITUTE,
DARJEELING,
June, 1960.

GYAN SINGH
Brigadier

[Mrs. Desirée Proud in *J. Bombay nat. Hist. Soc.* **53** (1): 71 records this species as 'very common' in the Nepal Valley all winter.—EDS.]

8. SOME THOUGHTS ON BIRDS OF PREY

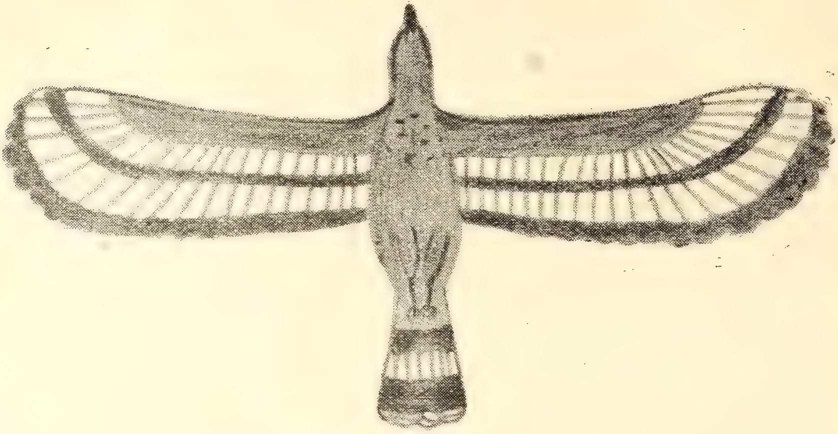
(*With a text-figure*)

Some years ago, in the offices of the Bombay Natural History Society, I was inspired to commence work on a new handbook of the Diurnal Birds of Prey, bringing up to date in one volume the available knowledge on all the species of birds of prey in the world, and the book is now well under way.

Once started on a task of this sort the writer early becomes aware of the inadequacy of the information already made available by those who had the chance to provide it—by which I mean the many collectors who have shot and skinned birds of prey in the past and are no doubt still doing so. They recorded a few basic measurements such as the wing, tarsus, culmen, and tail, often noted the state of moult, and usually noted the stomach contents. These are facts which tell you something about the bird after it is dead. But few have recorded the weight, the wing span (which I find strange because, in big birds, this is often a subject on which there is much conjecture), and the wing area, although these are facts which can tell you something about the bird in life, how it flies, how much it could possibly lift, and so on.

Then again, there is the question of descriptions. Few descriptions in standard works enable an observer to recognise a bird of prey high up, as big soaring species are seen more often than not. Most descriptions have been written from museum study skins, from which the underwing pattern, so vital to the field observer, cannot be adequately described. Perhaps the best example I know of this failing is the African Bateleur Eagle, *Terathopius ecaudatus*, where the male and the female can be distinguished at once by the underwing pattern at a considerable range, but only with some difficulty in any other way. This was a point that does not seem to have been noted by the many collectors who have shot Bateleurs.

I would therefore appeal to those who collect birds of prey at any time to weigh the bird, measure the wing span and total area (easily done by drawing the wing outline on a sheet of squared paper) and, most important of all, hold up the bird with wings spread against a strong light and make a diagrammatic sketch of the under wing pattern. It need only be very diagrammatic, something like the attached sketch of the Crested Serpent Eagle, *Spilornis cheela*, showing the main pattern of light and dark, and the fact that the wings are very broad and rounded, and that the tail appears rather long.



UNDERWING PATTERN *Spilornis cheela*

Another point that is very inadequately recorded, certainly for eastern species, is their calls. How often one finds some such remark as 'this bird can be recognised by its characteristic call'. The writer does not say what that call sounded like, and one is left none the wiser. 'A clear high scream' is better, but 'a clear high scream, *Peeeeee-ooo,*' is better still, as you then know that the first syllable is high pitched and long drawn out, the second lower pitched and shorter. To different ears and with variations this call could sound like *queeeee-loo* or *cheeeee-u*, but the basic characteristic of all these renderings is the same, and the reader then has a clear idea of what the call is like—again a vital means of identification for birds of prey which often soar and call high up in nuptial display. The calls of some eastern species have been described, but what sort of noise does *Hieraaëtus kienerii* make, or *Aviceda leuphotes*?

To come to another aspect of the study of birds of prey—their food. So many people seem to think that all birds of prey are harmful that authoritative descriptions of the food taken, with the prey species identified as accurately as possible, are needed to refute or confirm these views. I have a huge and powerful eagle nesting six hundred yards from my house in Kenya, and several of my neighbours have expressed alarm for their poultry. But I have been able to reassure them, for from long past experience I can say that the chickens are quite safe, this particular eagle being a mammal-eater living on hyrax and small antelopes, and I have never known it to kill a bird.

To give another example the African Fish Eagle, *Haliaettus vocifer* lives mainly on fish, and has therefore been thought by some to be a danger to fishery interests. In fact, however, it preys chiefly on the catfish *Clarias* and the lungfish *Protopterus* in Lake Victoria, both of them carnivorous fish which are a danger to the valuable *Tilapia* fisheries in that they take *Tilapia* already caught in gill nets. Thus, a bird which at first might be thought to be in direct competition with mankind is in fact beneficial. *Per contra*, there are several species of Snake Eagles (*Circaëtus*) in Africa, and all Africans with whom I have discussed the point think that because these birds eat snakes they *must* be beneficial. Study of the species of snakes taken, however, indicates that they are nearly all non-poisonous eaters of rats and mice themselves, so that on balance the eagles are probably harmful to man in that they kill predators on crop pests.

In assessing whether a bird of prey can be harmful or beneficial it is desirable to know not only what they eat, but how much. Some of the earlier work on this subject was most misleading. For example, authors would state that a pair of Golden Eagles would each eat at least one grouse per day and so decimate the population of these useful game birds. Recent work has shown that the daily food requirements of a Golden Eagle are from 9-12 ounces, or between 5 and 7 per cent of the bird's bodyweight. Thus a Golden Eagle, even when it eats a whole grouse weighing about 1½ lb., has taken a meal that will suffice it for two days.

In working on Golden Eagles in Scotland it had often puzzled me that these great birds were able to live and thrive in areas where there were very few prey animals such as grouse and hare. Tentatively I concluded that they must eat less than had been generally supposed, and in more recent surveys, correlating the amount of potential prey and carrion with the known food requirements of a Golden Eagle, it has become clear that in the hunting range of every pair the food supply is far greater than the birds can possibly consume. And this leads to the conclusion that it is not food supply alone which controls the population density in a bird like the Golden Eagle, which seems very surprising.

Long term studies of birds of prey, particularly the larger species, are difficult, because few of us have the time to make them. I have been lucky in this respect for I have been studying a group of eagles living on a particular hill for the past 12 years. When I first began this work there were six pairs of eagles on the hill, which had a total area of 4.2 square miles (*c.* 11 sq. km.). They hunted away from the hill of course, but they never made use of another similar hill of about the same area just across a valley. Despite 12 years' work I am still at a loss for the reason why all the eagles chose to nest on one hill and to ignore the other, apparently equally suitable hill.

From these studies, some interesting results have emerged. It seems, for instance, that big eagles breed less often than small eagles and may live longer. The largest eagle on the hill, the Crowned Eagle, *Stephanoaëtus coronatus*, has made 7 attempts to breed in 12 years, has reared five young in that time, and is rearing a sixth as I write. The smallest eagle, a very rare species Ayres's Hawk-Eagle, *Hieraaëtus ayresii*, has made an attempt to breed in each of 11 years, and has reared 10 young; in only one year was breeding unsuccessful. This seems to indicate that big eagles might be longer lived than small eagles, and the supposition is borne out by the fact that at the Crowned Eagle's nest there have been only two changes of mate in 12 years, while at the Ayres's Hawk-Eagle's nest there have been certainly three, and probably four, changes in eleven years. At both nests a succession of different birds occupies the nest, and one female and one male Crowned Eagle have each lived a minimum of eight years in the wild state.

This is the sort of study which takes time and requires the luck to be able to watch the birds for many years. One must start at the age of 20 and go on as long as the strength lasts. But there is a great deal of simpler and equally interesting work to be done on Indian birds of prey. For instance, I cannot find anywhere a properly detailed account of the nesting of that common bird the Brahminy Kite, though my own scant observations have indicated that only the female incubates and that she is fed on the nest by the male. And there are other species which are rarer and consequently still less well known. The value of the new monograph on the birds of prey would be greatly enhanced by careful studies of even a single nesting cycle, and it is to be hoped that additional information about some Indian species will come to hand before it goes to press.

KAREH,
KENYA COLONY, LESLIE H. BROWN
October 10, 1960.

9. THE ASHY REEF HERON, *EGRETTA GULARIS* (BOSC) ON THE EAST COAST

In spite of paucity of records from Eastern India the Ashy Reef Heron, *Egretta gularis* (Bosc) is an established resident here all along the tidal mud-flats and estuarial areas of our coast. I have seen it all along the coast from Moipadu—nearly due east of Nellore to the upper reaches of the lagoon known as Pulicat Lake, at Moipadu, Krishnapatam, Muttukur, Durgarajupatnam, and on the coast east of Mallam.

It breeds during the summer from around April to May and there is a colony that nests in a grove of *Ficus* trees just four hundred yards due east of the Forest Bungalow on the northern bank of the estuary. The birds are always seen, commonly along the Buckingham Canal, tidal mud-flats, and the shallow waters of the estuary, usually solitary or in pairs, stalking about on the mud or in shallow waters, catching small crabs, molluscs, small fish, and prawns. The slaty-blue phase of plumage is in the majority and the breeding plumes, two long elongated feathers forming a crest, are donned after the cold weather is over, and the birds moult into their summer plumage. There is no occasion when I have not seen it along the coast in the environments mentioned. It is common and resident and well established.

GUDUR (NELLORE),
S. INDIA,
November 25, 1960.

K. M. KIRKPATRICK

10. OCCURRENCE OF THE SHELDUCK [*TADORNA TADORNA* (LINN.)] IN BHAVNAGAR, GUJARAT STATE

In the evening of 29th December 1960 I saw for the first time the Shelduck, *Tadorna tadorna* (Linn.) in the salt pans in Bhavnagar. The following morning with Shri Shivrajkumar and Shri Lavkumar of Jasdan I watched them again while they were feeding and it was noticed that two of them were drakes. They were seen again on the 31st December.

I wonder if this is the southernmost record for this species in India?

DIL BAHAR,
BHAVNAGAR, R. S. DHARMAKUMARSINHJI
January 7, 1961.

[South of Sind the Shelduck is a rare winter visitor. In Kutch Col. C. B. O'Brien shot one near Bachan, while in Saurashtra a pair was shot at Balambha 36 miles (*c.* 58 km.) north-east of Jamnagar on 28th December 1918. Hume recorded it from 'the mouths of the Indus, coasts of Gulf of Cutch, and from Nowanugger, Kathiawar'. Eastwards it has been obtained at Chilka Lake, Orissa, and extends into Manipur and Burma. McCann noticed it at the Tulsi Lake near Bombay, while it has been shot and/or noted near Poona and on the Bhima River, 10 miles (*c.* 16 km.) south of Pandharpur, Sholapur District, Maharashtra (Betham, *J. Bombay nat. Hist. Soc.* **13**: 187).—EDS.]

11. OCCURRENCE OF THE BLACKNECKED GREBE, *PODICEPS CASPICUS* (HABLIZL), NEAR POONA, MAHARASHTRA

On the 20th October 1960, while shooting about 30 miles (*c.* 48 km.) out of Poona along the Sholapur Road, we saw some duck on a small tank along the road. After the first few shots the duck cleared out leaving a few grebes (*Podiceps ruficollis*) and a pair of coot. Through glasses one of the birds appeared to be slimmer and settled higher out of the water than the others. It also showed more white on the front of the neck, no doubt offset by the dark on the head and nape. It was impossible to approach it in a canoe as it dived while well out of range and swam considerable distances under water. After one or two attempts we left the place, but making another attempt in the afternoon the bird was secured and found to be a male Blacknecked Grebe, *Podiceps caspicus* (Hablizl). This appears to be a considerable southward extension of the known range of this bird in India, the nearest record being from Bhavnagar, Saurashtra (now Gujarat) (Dharmakumarsinhji, *J. Bombay nat. Hist. Soc.* **50** : 664).

FAIZ & CO.,
75, ABDUL REHMAN STREET, HUMAYUN ABDULALI
BOMBAY 3,
October 28, 1960.

[As the wing measured 141 mm. against 126 mm. in the ♂ from Bhavnagar and 125-138 mm. (average 133 mm.) in 5 specimens from Iraq, both the Indian birds were sent to Dr. E. Stresemann at the Berlin Museum, who has very kindly confirmed our identification.—Eds.]

12. NOTES ON SOME NEPALESE BIRDS

Phylloscopus fuligiventer (Hodgson). We have found this bird to be quite common in the Rapti Valley, the Dun country to the SW. of Kathmandu. It is found only along the edges of streams, where these have dense vegetation, grass or bushes along their banks. It frequents both tiny streams, a foot or so wide, with the grass meeting above the water, and the large slow-flowing rivers which are a characteristic of the grasslands of this Valley. I have seen them from Hitaura at 1200 ft. (*c.* 370 m.) to the banks of the Narayani River at 600ft., (*c.* 180 m.). The first time I encountered it I thought from its behaviour that it must be a bush warbler or even some kind of chat. It looks very dark in the field, keeps on or near the ground, and constantly utters a little 'Cht . . . cht'. I was quite amazed when my husband shot it, to find it was a *Phylloscopus*. Since then I have watched them many times. They are very easily observed on the larger rivers as they are not at all shy, and come freely out on to little islands, stones or pieces of driftwood in the river bed. They often flutter over the water, catching insects, and hovering for a minute above the water as they do so. On the larger rivers they are usually in pairs, but on the smaller streams often solitary, perhaps because here the food supply is less abundant. I have never seen them leave the rivers and they keep entirely to the vegetation growing within a couple of feet of the water. Where there are tall stiff grasses they will occasionally work their way up to 4 or 5 feet but usually they keep close to the water or the ground on its banks. There seem to be few records of this bird, and I was very surprised to find it so common locally. We generally spend a fortnight at Christmas in the Rapti Dun, so my observations are only for the last fortnight in December and first week of January. Since discovering its habitat I have never failed to find it on any suitable stream. I have never seen it in the Kathmandu Valley on migration, but there is no suitable country for it there. If it breeds at very high elevations in Tibet, it may travel down the great rivers, 5 of which are united in the Narayani River, where it passes through the Duns at Naraingarh. We shot two birds which I compared with skins in the British Museum. I only saw a few skins but these appeared to be identical in colour with my specimens. Dr. Fleming, obtained a female at Bilauri in West Nepal (Rand & Fleming, *Birds from Nepal* : 165) but otherwise I know of no recent records. I see that Dr. Rand considers it as probably a race of *P. fuscatus*, a species I have never seen in central Nepal.

Both my birds are males. Wing formula 2 = 10. Wing measurements 53 and 54 mm. This seems rather small compared with Dr. Fleming's bird (60 mm.) and the measurements given in Dr. Ticehurst's GENUS PHYLLOSCOPUS.

I should be very interested to hear from anyone who has any information on this bird.

Emberiza leucocephalos Gmelin. The Pine Bunting. We found these birds quite common during the latter part of November in the hills along the Seti River, north of Pokhara in West-Central Nepal. They were in small flocks and of course in winter plumage. I have never seen them in the hills round Kathmandu, and suppose Pokhara to be about the eastern limit of their range.

Haematospiza sipahi (Hodgson). The Scarlet Finch. This bird is seen occasionally on the hills round Kathmandu in winter. Several sight records and we obtained a female on Sheopuri at 8000 ft. (*c.* 2440 m.) on 2nd February. All we have seen were in oak forest.

Aethopyga ignicauda (Hodgson). Firetailed Sunbird. The breeding range of this species and *A. nipalensis* never overlaps, as this bird breeds between 10,500 (*c.* 3200 m.) and 12,000 ft. (*c.* 3650 m.) and *nipalensis* never above 9000 ft. (*c.* 2740 m.). In winter they are found at the same elevations 4000-8000 ft. (*c.* 1220-2440 m.). During January and February when *ignicauda* is in eclipse *nipalensis* is the dominant bird. Flowers are rather scarce at this time, and I have watched the two species in flowering *Elaeognus latifolia*, with *nipalensis* very aggressive, and *ignicauda* always giving way, retreating to a lower part of the tree, and finally leaving the area altogether, sometimes pursued a short distance by its rival. In March when *ignicauda* is in full plumage the situation is reversed, and it is the Nepal Sunbird which gives way, and generally leaves a tree in which it has been feeding on the arrival of *ignicauda*. When there is an abundance of blossom, as when the *Leucosceptrum canum* is in full bloom there seems to be no rivalry between the species, and flocks of both these birds together with *A. saturata* and *A. siparaja* will feed amicably together in the same trees.

Vanellus cinereus (Blyth). The Greyheaded Lapwing. I can find no records of this bird in the Kathmandu Valley, but it is in fact quite a common winter visitor from the end of September to the end of March. Flocks of from 6 to 20 birds being usually found along the Manora River, feeding in old rice fields. A large proportion of the birds are usually immatures without the dark pectoral band.

BRITISH EMBASSY,
KATHMANDU,
NEPAL,
January 3, 1961.

DESIRÉE PROUD

13. SOME BIRD RECORDS FROM NORTHERN BURMA WITH A DESCRIPTION OF A NEW SUBSPECIES

Mr. Oliver Milton, a field associate of this Museum, made a long trip in Burma from November 1958, through December 1960, on behalf of a project known as the Burma Wildlife Survey sponsored by the Conservation Foundation of New York, the New York Zoological Society, the American Committee for International Wildlife Preservation and the Peabody Museum of Natural History of Yale University. During this trip Mr. Milton had the co-operation of the Burma Forest Department, and officials of the Burma Government throughout were the soul of courtesy and help as indeed they always are. It is very much to be hoped that Mr. Milton's arduous work which resulted in concrete recommendations to the Government of Burma for wildlife sanctuaries throughout the less encroached-upon and wilder portions of that wonderful country will eventually form the basis for an extension of the present park and reserved forest system. The larger mammals such as the rhinoceros are in great danger of following the European aurochs into oblivion. May the sad examples of neglect of animal species in other countries be heeded by the Governments of the nations of Southeast Asia.

Some areas of northern Burma are still very little known as far as the distribution of birds is concerned (*vide* Smythies, 1953) and I had asked Mr. Milton when he was in such areas to make some observations on birds and collect a very few specimens here and there which might add to the knowledge of the distribution of the Burmese avifauna. Though hampered by physical difficulties and other primary duties, Mr. Milton collected some records which are worthy of note, particularly in two previously uncollected areas:

(*a*) Hpungran Wang, a locality west of Putao in extreme northwest Burma, Long. 97° E., Lat. 27° 35′ N., about fifty-five miles (*c.* 88 km.) southwest of the Adung Valley.

(*b*) Mount Saramati, highest mountain south of the Himalayas, lying on the India-Burma border in the Naga Hills, Long. 95° 03′ E., Lat. 25° 45′ N., reaching a height of over 12,500 feet (3800 m.) above sea level. On my trip to the Indian Naga Hills (1952), I attempted to reach Mount Saramati from the Indian side without success although I climbed Mount Zephu, a lower [8408 ft. (*c.* 2560 m.)] feature of the same chain. We could see Saramati plainly and my heart beat faster each time I gazed fondly at its grassy alpine-appearing upper slopes, fancying the unknown forms of animals to be found there. As I wrote then: 'But this problem (the ascent of Saramati) will remain for another attempt. I certainly wish much luck and God-speed to the ornithologist who visits that challenging mountain.' Mr. Milton's trip was of course not really ornithological. But the fact that he could make any observations at all on the birds of Saramati, and that now after ten years I could examine a few specimens has seemed to me almost like an answer to an ornithological supplication.

Following is a list of some of the records of specimens:

1. **Alcedo hercules** Laubmann

A male in breeding condition was taken February 18, 1951 at Shangawng, Putao District. This is perhaps the third record for Burma (Stanford & Ticehurst, 1935).

2. **Jynx torquilla chinensis** Hesse

A female from Hpungran Madin, Putao District April 5 at 7500 feet (*c.* 2280 m.) above sea level is worth recording.

3. **Picus canus sordidior** (Rippon)

A male from Kutkai, northern Shan States taken at 4500 feet (*c.* 1370 m.) appears to represent this Yunnan subspecies.

4. **Serilophus lunatus rubropygius** (Hodgson)

A female from Sawkuti, Naga Hills near Saramati was collected at 3000 feet (*c.* 910 m.) altitude. I feel that these Broadbills can be combined into one species and are allopatric in their distribution.

5. **Sturnus malabaricus malabaricus** (Gmelin)

A female from Homalin on the upper Chindwin belongs to the nominate form rather than *nemoricola* as listed by Smythies (tom. cit.) 1953.

6. **Garrulax caerulatus livingstoni** Ripley

A specimen collected at Sahpao, Naga Hills near Saramati belongs to the race described from Mount Japvo, Indian Naga Hills (1952) extending the range quite logically into this adjacent area of northwest Burma.

7. **Garrulax rufogularis rufiberbis** (Koelz)

In contrast to the above, a single specimen of *Garrulax rufogularis* from Wailam Sanghkao, northeast of Saramati in the Naga Hills belongs to a greyer, paler population rather than to *assamensis* of the adjacent Indian territory. This race was described in 1954 from Htawgaw.

8. **Actinodura waldeni saturatior** (Rothschild)

A single bird from Hpungran Wang, west of Putao, matches Rothschild's description (1921) in having a blackish crown with pale silvery grey margins, in being dark above and below with rusty yellow edgings on the feathers of the under surface, and with more silvery grey ear coverts. This description applies also to *Actinodura nipalensis wardi* Kinnear (1932) described from the Adung Valley some fifty miles (c. 80 km.) as the crow flies from Hpungran Wang. It seems wiser, therefore, to make *wardi* a synonym of *saturatior* as Ticehurst (1935) first suspected.

A specimen from the vicinity of Mount Saramati agrees with topotypical *waldeni* from Mount Japvo in the Indian Naga Hills (Barrail Range), although in general coloration it is a trace paler.

This species should be separated from *nipalensis*, being entirely different in plumage pattern, as Rothschild (1926) long ago pointed out.

9. **Garrulax striatus cranbrooki** Kinnear

A small series from west of Putao measure:

Putao :	Wing ♂ 139, 145.	♀ 140.5, 142 mm.
Mishmi Hills. Assam :	Wing ♂ 140, 147.	♀ 133, 141 mm.

As Ticehurst pointed out (1935) the differences between *cranbrooki* and '*austeni*' (preoccupied in *Garrulax*, now = *brahmaputra* Hachisuka, 1953) are minor. I have compared these fresh skins and our series from the Mishmi Hills of Assam adjacent to the Dafla Hills, the typical locality for *brahmaputra*. There appears to be no difference in size and the soiled or clear colour of the striae on the ear coverts is somewhat variable. One out of five Burmese skins has whitish striae, one out of four Mishmi and Margherita birds has more buffy, less whitish striae. In this case it would seem useful to combine the two populations under the one name *cranbrooki* (1932) which has priority over *brahmaputra*.

10. **Yuhina bakeri** Rothschild

Obtained in the Burmese Naga Hills at Sawkkye in November as well as west of Putao.

11. **Yuhina flavicollis rouxi** (Oustalet)

This is a rather variable form, and I think we were unwise to salvage the subspecies *baileyi* (Baker) for the population of the Mishmi Hills (1948). Three additional specimens from west of Putao show considerable variation in the colour and amount of pale shaft streaking of the upper parts and the colour of the nuchal collar. Perhaps all the birds of northern Burma and northern and eastern Assam should be combined under this one population name.

12. **Alcippe vinipectus austeni** (Ogilvie-grant)

A specimen from the Burmese side of Mount Saramati proves, as might be expected to belong to the Assam Naga Hills subspecies.

13. **Muscicapella hodgsoni hodgsoni** (Moore)

A male in breeding condition was taken April 4 at Hpungran Wang, western Putao adding a new district to those from which this little-known flycatcher has been recorded in Burma.

14. **Phoenicurus hodgsoni** (Moore)

Shangawng, Putao District, February 18.

15. **Seicercus poliogenys** (Blyth)

A single male was collected at Hpungran Wang, Putao, in November.

16. **Seicercus castaniceps castaniceps** (Hodgson)

A male in breeding condition was taken March 30 at Hpungran Wang, western Putao district.

17. **Phylloscopus davisoni disturbans** La Touche

From Kutkai, northern Shan States, a male taken December 3 has faint white edges to the inner webs of the outer rectrices and evidently belongs to this form.

18. **Parus rubidiventris saramatii** new subspecies

Type: ♂ ad. (Y.P.M. No. 61240), collected December 9, 1959, on Mount Saramati, Naga Hills by Oliver Milton.

Diagnosis: from *beavani* of the Himalayas and extreme northern Burma, this form differs markedly by having the underparts deep olive grey washed with drab, more particularly on the centre of the belly and under tail-coverts. The upper parts are buffy olive rather than blue-grey. From *rubidiventris*, this form differs on the upper parts by being greyish buffy olive, rather than olive brown, the grey with a faint isabelline cast, more pronounced on the rump. Below of course these birds are again deep olive grey washed with drab rather than grey.

Measurements : Wing ♂ 66.5, ♀ 65 ; tail ♂ 48, ♀ 46.5 ; culmen ♂♀ 10 (2).

Remarks: these two specimens were collected at an altitude of 10,500 feet (*c.* 3200 m.) in heavy rhododendron forest. The feet are marked as black on the labels. This is the first record for this species south of the Brahmaputra River or, in Burma, south of the Adung Valley or the Htawgaw area east of the Triangle. In both these localities *beavani* has been taken at altitudes of approximately 12,000 feet (*c.* 3600 m.) above sea level.

19. **Sitta formosa** Blyth

In view of the rarity of records of this species from Burma, it should be recorded that a female was collected on Mount Saramati on December 12 at an altitude of 5200 feet (*c.* 1580 m.).

YALE UNIVERSITY,
PEABODY MUSEUM OF NATURAL HISTORY,
NEW HAVEN, CONNECTICUT, U.S.A.,
March 3, 1961.

S. DILLON RIPLEY
Director

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14. BIRD MIGRATION IN INDIA

Recovery of Ringed Birds

No.	Date and place of ringing	Species	Ringed by	Date and place of recovery	Reported by
Moskwa D-410 613	9-7-1959, Son-Kul Lake (*c.* 41°48′ N. 75° 0′E.), Kirghiz SSR.	*Tadorna ferruginea* Juvenile	Bird-Ringing Centre, U.S. S. R. Academy of Sciences, Commission for Nature Protection, Moscow.	16-10-1959. One of 7. Shot 20 miles (*c.* 32 km.) south of Lahore, Pakistan.	Mian Nasim Akhtar, 57, Haq Nawaz Road, Baghbanpura, Lahore, W. Pakistan.
Moskwa E-551 777	16-7-1959. Kurg adzhin Lake (*c.* 50°30′N.; 69°35′ E.), Kazak SSR.	*Anas clypeata* Adult ♂	do.	28-2-1960. Near Sonepat [40-50 miles (*c.* 64-80 km.) north of Delhi].	Reported to B.N.H.S. by Bird - Ringing Centre, Moscow.
Moskwa A-55 675	13-7-1959. Son-Kul Lake (*c.* 41°48′ N.; 75°10′E.), Kirghiz SSR.	*Anser indicus* Juvenile	do.	25-3-1960. Near Gilgit (Kashmir).	do.
Moskwa C-104 623	11-6-1960. 5 km. N. from Koktubey, Tarunovka district, Dagestan, East of Caspian Sea, U.S.S.R.	*Platalea leucorodia* Juvenile	Bird-Ringing Centre, U.S. S.R. Academy of Sciences, Commission for Nature Protection' Moscow.	8-1-1961 Sitamau tank. NE. of Sitamau Town (24° 2′ N., 75° 22′ E.), Madhya Pradesh.	Shot by Sepoy Razak Mohamed and reported by Dr. Raghubir Sinh, M.P.

BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD,
BOMBAY 6,
January 7, 1961

EDITORS

15. A SPECIAL METHOD OF FISHING FOR *CLUPISOMA GARUA* (HAMILTON) IN THE GANGA RIVER SYSTEM

Apart from the traditional methods of catching *Clupisoma garua* (Hamilton), a schilbeid fish of commercial importance in the Ganga system, there are various interesting methods of 'baiting' this fish, some of which have been described by Faruki & Sahai (1943) and Job & Pantulu (1953). During the course of certain investigations in the Ganga and the Brahmaputra rivers, the authors came across a novel but effective method of catching *Clupisoma garua* by alluring, which is described in the present note.

The method, which in local dialect of North Bihar is known as 'Lahke ke Mārnā' or 'catching by alluring', is quite prevalent in the River Ganga between Bhagalpur and Sahibgunj in Bihar and between Jorhat and Tezpur along the Brahmaputra in Assam. It is effectively employed during March to June in the Ganga and December to April in the Brahmaputra. In one single operation by six fishermen observed at Bhagalpur, as much as 75 kilograms of *C. garua* were caught by this method. The whole operation which takes about 5-6 hours is carried out in three steps as follows:

(i) Preparation and casting of bait.

(ii) Alluring the fish to a selected area.

(iii) Netting operation.

For preparing the bait, small pieces of enterons of a goat are boiled for some period and then sun-dried and crushed to powder. This powder is mixed with some quantity of goat-fat and dried cow-dung to make up the bulk of the bait, which is then soaked in crude oil extracted from the Gangetic Dolphin, *Platanista gangetica*, a Cetacean commonly occurring in the Ganga system. The odour emitted by the Dolphin oil is very strong and pungent and according to fishermen, *C. garua* favours this smell and is greatly attracted by it. For one operation, about 8 kilograms of bait is prepared which includes 3.75 kgm. of goat enterons, 0.12 kgm. of goat-fat, 3.0 kgm. of dried cow-dung and 0.93 kgm. of crude Dolphin oil.

The bait is cast in the water in small bits either from a boat or a raised platform erected in shallow parts of the river. The strong penetrating smell of the bait attracts *C. garua* and it is reported by fishermen that fishes even from a distance of three miles move towards the source of smell.

When a considerable number of fish are lured, the person casting the bait gets off from the platform or the boat to stand in chest-deep water and commences agitating the water with one hand and throwing about bits of the bait with the other. Attracted fish approach towards the person and at times they are known to cling to his body. When a sufficient number of fish have been lured around this person, he gives a signal to other fishermen in the boat. Four to six fishermen with a small drag net, locally known as 'Bisārā' (measuring 11.6×7.3 metres with the mesh size of 1.27 cm., made from cotton twine), enter the water some distance upstream and drag the net towards the person with the bait to haul in all the fish lured into the area.

In the Brahmaputra, the operation is slightly different. The bait made up with bright yellow Dolphin oil, liberal quantities of macerated Dolphin flesh and dried cow-dung, is thrown in the river from a boat and on reaching shallow portions along the bank, larger quantities of bait are cast. After an interval of about 2-3 hours the fishermen drag-net the area steeped with '*garua*' bait. Inquiries in the area revealed that this method of fishing is mostly practised by Bihar fishermen settled down along the Brahmaputra in Assam.

The fact that only *C. garua*, to the complete exclusion of other riverine species of fish, are caught by this method is very significant and it would appear that the olfactory perception in *C. garua* is highly developed.

CENTRAL INLAND FISHERIES,
RESEARCH SUB-STATION,
ALLAHABAD (U.P.),
September 18, 1960.

M. P. MOTWANI
C. B. SRIVASTAVA

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16. *HETEROPNEUSTES FOSSILIS* (BLOCH), A NEW ADDITION TO THE FRESHWATER FISH FAUNA OF THE ANDAMAN ISLANDS[1]

(*With one text-figure*)

During a recent visit to the Andaman Islands in February-March 1960, we were able to collect, besides other species, 8 specimens of the catfish *Heteropneustes fossilis* (Bloch) measuring from 99 to 245 mm. in standard length from a stream near the forest rest camp about seven miles (*c.* 11 km.) from Mayabundur, Middle Andamans. Subsequently, ten more specimens of the same species were obtained by us from a local resident of Port Blair, South Andamans, who had collected them from a nullah at Fararguni, about six miles (*c.* 9 km.) from Port Blair. A perusal of the literature shows that Blyth (1858, 1860), Day (1870), Annandale & Hora (1925), Mukerji (1935), Hora & Rao (1938), and Herre (1939, 1941), who have all reported on the fishes of the Andaman waters, have not recorded this species from there. The freshwater fish fauna of the islands has been fairly well studied and it is unlikely that this species could have escaped notice of the above workers. In view of this, we are inclined to believe that *H. fossilis* is a more recent introduction and from its occurrence in streams in both Middle and South Andamans, it would appear that the species is well established in these islands.

We were interested to find four of the ten specimens from Fararguni showing abnormality as regards the number of barbels. The normal complement of barbels for this species is four pairs, one nasal, one maxillary and two mandibular pairs. In three of the aforementioned specimens the inner pair of mandibular barbels are totally absent, while in the fourth specimen only one of the inner pair of mandibular barbels is absent (Text-fig. *a-c*). The position of these missing barbels is indicated by depressions, but there is no indication that the loss is due to external injury. To our knowledge this kind of an abnormality has not been reported for *H. fossilis*, although similar conditions have been noted among some members of the family Siluridae. The fact that all these ten specimens exhibit weak and flexible pectoral spines instead of the strong and well-ossified condition as seen in the specimens collected near Mayabundur, suggests that

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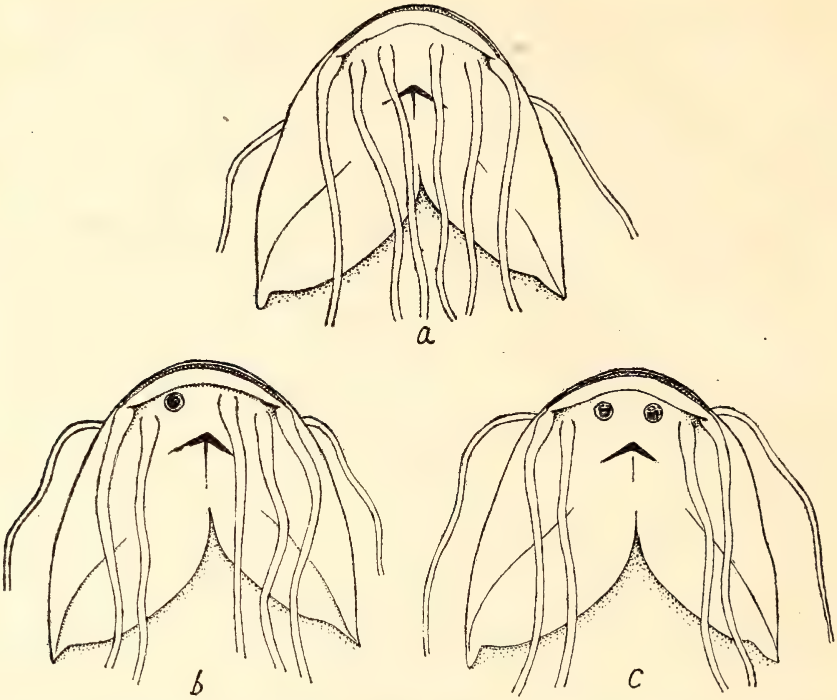
[1] Published with the permission of the Chief Research Officer, Central Marine Fisheries Research Station, Mandapam Camp.



Text-figure *Heteropneustes fossilis* (Bloch): (*a*) Ventral view of head showing the normal complement of four pairs of barbels; (*b*) same, with one of the inner pair of mandibular barbels absent; (*c*) same, with the inner pair of mandibular barbels absent.

these abnormalities may be on account of some localised environmental phenomena rather than being of any genetic significance. In characters, such as the body proportions, dentition, etc., both the samples agree and in order to facilitate comparison with the mainland representatives of the species, the frequency of occurrences of three of the meristic characters of these specimens are given in the accompanying table wherein A- and B- refer to samples from near Mayabundur and Farargunj respectively.

TABLE

	Anal Fin Rays																				
	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
	—	—	—	1	1	—	—	—	1	—	—	1	2	—	—	1	—	—	—	1	—
	—	—	—	—	—	1	—	—	2	2	2	1	2	—	—	—	—	—	—	—	—

	Dorsal Fin		No. of Gill-rakers on lower Limb of outer Arch									
	1,6	1,7	18	19	20	21	22	23	24	25	26	27
A-	1	7	—	—	2	3	1	—	1	—	—	—
B-	10	—	—	2	5	3	—	—	—	—	—	—

Freshly collected specimens, especially the larger ones had a light yellowish tinge all over the body. On preservation this was lost, but the specimens retained the two characteristic lighter bands, one above and one below the midlateral line of the body.

Central Marine Fisheries Research Station,
Mandapam Camp,
September 14, 1960.

E. G. SILAS
E. DAWSON

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17. NOTES ON THE BIOLOGY OF THE TREE-ANT *TECHNOMYRMEX* SP. NEAR *ALBIPES* SMITH (DOLICHODERINAE: FORMICODEA)[1]

(*With a photograph*)

INTRODUCTION

Although several species of ants belonging to Dolichoderinae are known from south India, very little information is available about them. The genus *Technomyrmex* Mayr has not so far been reported upon from this region. The species *Technomyrmex* sp. near *albipes*

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[1] Communicated by the Dean, Agricultural College & Research Institute, Coimbatore.

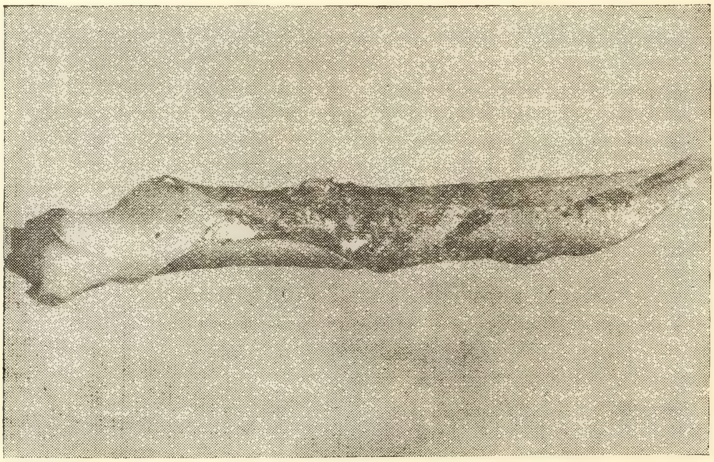
Smith has been noted in Coimbatore. The details of the life-history and habits of this ant are presented in this paper.

GENERAL CHARACTERISTICS

The black tree-ant (*Technomyrmex* sp.) occurs commonly on mango trees and is completely arboreal. The workers are completely black and about 2 mm. in length. The queen is only slightly bigger than the worker and is not easily distinguished in the nest. The ant does not possess a sting but only repugnatorial glands in the anal region characteristic of the subfamily which produces the typical 'Tapinoma' odour somewhat resembling the smell of rancid coconut.

NESTING HABITS

The ant prefers to build its nest in bushy portions of the tree and chooses shady places with overhanging branches. The nest is built in a single leaf by rolling the leaf blade up along its longitudinal axis on the upper surface. The sides of the leaf are brought together to about 5 mm. of each other and are woven together by a silken web. The silk is white and the weaving is done in a close knitting to form a thick and tough sheet. This silken sheet is continued on the surface of the leaf also and stuck to it. In the open portions it extends as a roofing. Thus the nest gets a complete covering of the silk on all sides in the interior portion. The chamber that is formed is about 8 to 15 mm. in width and extends to the whole



Nest of *Technomyrmex* sp. near *albipes* Smith length of the leaf, to about 10 cm. The distal edge of the nest is closed and the entrances to the nest are situated only in the proximal portion. There are two or three small entrances through which the ants squeeze themselves through. There are also loose strands of silk near the entrances in which dirt gets entangled. It then looks like the nest of a spider which has been abandoned.

ORGANISATION INSIDE THE NEST

The ants keep the interior of the nest scrupulously clean and crowd together in the small space available in large numbers. There is only one queen in the nest; the others are all workers, and all of the same size. Eggs, larvae, and pupae are stored in different places in the nest but are not separated out into chambers. These stick together by the mucilaginous material that is usually present on their surface due to the constant licking by the workers. The population of a nest examined in September was as follows: Workers 1156, eggs 51, larvae 92, and pupae 45.

No food material is stored in the nest nor have any inquilines been noted in them.

SEASONAL HISTORY

The activity of this ant begins with the rains in July-August when the new shoots of the tree are beginning to get tough. Only a few nests have been noted on stray trees. However, there were three nests on one tree alone. The nests were also found only in one portion of the Agricultural College orchard, from which fact it may be presumed that the species is not widely prevalent in this area.

The nests are found only in the green leaves and not in dry or fading leaves. This shows that the ant founds the colony every year in the leaves of the previous year which give some rigidity, and the colony is abandoned by the next year when the leaves may dry and fall. Thus the colonies exist for only one year.

LIFE-HISTORY

For making observations on the development of the immature stages, the nests were introduced in closed jars with the workers allowed to move freely in them. Since the workers are accustomed to wandering, this life in a confined area was not quite suitable for their normal activity and development. Fresh workers were introduced now and then so as to give favourable conditions for their development. Some of the workers did not take kindly to the larvae possibly because they did not accept them as belonging to their nest. A small portion of the brood, however, survived and the following results were obtained regarding their life-history.

The eggs were about 0.3 mm., elongate and white, covered with a mucilaginous substance which was probably due to the licking of the workers. The incubation period ranged from 4 to 8 days with an average of 5.77 days. The first instar larva was stout, slightly tapering to the anterior end, and covered with thin short hairs sparsely over the body. It measured about 1 mm. The duration of the first instar ranged from 4 to 7 days, with an average of 5 days. The second instar resembled the first with a curvature in the anterior end and more hairs on the body. It lasted from 5 to 8 days, with an average of 6.44 days. The third instar measured about 1.5 mm. and was covered with more hairs than the previous instar. It lasted 2 to 4 days and averaged 3 days. After this instar the larvae pupated in naked pupae which were again licked by the adults. Those that were not licked failed to emerge as adults. The pupal period lasted 5 to 7 days, with an average of 6.5 days. Thus, the total life cycle worked out to an average of 26.71 days.

FOOD AND OTHER HABITS

Being a Dolichoderine ant, it fed on the saccharine exudations of Coccids which are generally found on mango trees. The Coccids on which it commonly attended were *Rastrococcus iceryoides*, *Phenacoccus mangiferae*, and *Pulvinaria psidii*. It attended only occasionally on the aphid *Toxoptera odinae*. Its other food material appears to be dead insects and other dead animals which are found in the tree. These are brought to the nest and, after feeding on them, the remains are left behind on the silk as dirt.

The ant is able to run quite fast and is very timid. There appears to be no regular track on the tree and it has to use its sight for finding out the food material. It is often found on a tree on which the red tree-ant, *Oecophylla smaragdina*, lives, but it confines itself to the branches not ordinarily frequented by them. The red tree-ant, similarly, avoids the branches occupied by this stingless tree-ant. When they meet on the branches of the trees, no enmity is shown by either of the ants each going about its own way and not interfering with the other.

Since this tree-ant is stingless it is harmless, and when alarmed it only tries to run away. It is unable to make a concerted attack on any of its enemies. When the nest is disturbed, the workers carry away the larvae in their mouth to some place of safety. It thus lives unobtrusively on the tree avoiding trouble from all quarters.

The communication between members of the colony appears to be by stroking the antennae only. The mutual licking and feeding by regurgitation goes on as is usual in most of the ants.

INQUILINES AND PARASITES

No inquilines or parasites have so far been noted in the nests or the trails of the ants.

ACKNOWLEDGEMENTS

The writer acknowledges with grateful thanks the permission accorded by the University of Madras for publishing material which formed part of a thesis for the M.Sc. degree. Thanks are also due to the Government of Madras for permitting me to conduct research in the Agricultural College and Research Institute, Coimbatore. The writer is specially thankful to Sri. M. Basheer, Government Entomologist, for help rendered in various ways as Supervisor during the course of the studies.

AGRICULTURAL COLLEGE
& RESEARCH INSTITUTE,
COIMBATORE,
September 26, 1960.

A. LEELA DAVID, M.SC.,
Assistant Entomologist.

18. NOTES ON A NEW PEST, *SPHENOPTERA DEDUCTA* KERR. (BUPRESTIDAE : COLEOPTERA) OF THE MAT-GRASS, *CYPERUS TEGETUM* (ROXB.), IN SOUTH INDIA[1]

The mat-grass or *Korai*, *Cyperus tegetum* (Roxb.) is grown on an extensive scale in some localities in the States of Madras and Bengal [Krishna Pillai, N. (1935): Cultivation of Korai (*Cyperus tegetum*) or mat-grass in N. Arcot District. *Madras Agric. J.* **23** : 371], and yields valuable grass with which mats are made. Although the mat is in common use in almost every house in India, very little is known about the mat-grass. In recent years it has been prized as a cash-yielding crop. In Madras State it is grown as a perennial crop in Wandi-Wash and Cheyyar taluks on a large scale. So far no insect has been known to damage the plants; therefore, the outturn of, and the cash return from, the crop was well assured. This year, however, a jewel beetle, *Sphenoptera deducta* Kerr., appeared on a mass scale causing considerable injury to the crop. The characteristics of the beetle and the damage by it to the crop are described below.

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[1] Communicated by the Dean, Agricultural College & Research Institute, Coimbatore.

S. deducta Kerr. does not appear to have been mentioned as a pest in the lists of Indian Insect Fauna so far. Insect collections in the Agricultural College and Research Institute, Coimbatore, include specimens of this species collected on nut-grass, *Cyperus rotundus,* in Malabar and Coimbatore. No further information is available on the occurrence or the distribution of the species. This is the first record of the insect on *C. tegetum* (Roxb.) in this region.

MORPHOLOGICAL FEATURES OF THE INSECT

The beetle is about 1.5 cm. in length and dark shiny brown in colour on the dorsum of the body including the elytra, as well as on the sternum. It is covered with a dull white powder which gets wiped off on handling. It is ovoid-elongate in shape with a width of about 0.6 cm. in the middle. The head is truncated, as is typical for the genus, and is closely embedded vertically in the thorax. The thorax is rectangular with the elytra elliptical. The ventral portion is yellowish on the sides and brownish in the middle.

The antennae are short, serrate, black in colour, and composed of 11 segments. They are placed in the anterior portion of the head. There is a patch of metallic green colour on the frontal portion of the head. The legs are fairly long and black.

HABITS OF THE INSECT AND NATURE OF INJURY

The beetles usually rest on the culm of the plant just below the inflorescence with their heads pointing downwards. During the middle of the day when there is good sunshine and the day temperature is high, the beetles crawl up to the leaves and begin gnawing away portions from the sides. In several cases each leaf may have 2 or 3 beetles. Continuous feeding by the beetles causes complete defoliation of the plant and they begin to wilt from the tip. Cuttings of the crop are usually taken every six months. Damage by the insects, however, causes the plants to wither away in two or three months.

On disturbance the beetles feign death and fall down from the plants. They have a quick and strong power of flight and fly away long distances.

SEASONS OF OCCURRENCE

The beetles occurred on a large scale in Thennangur (Wandi-Wash taluk) and Vadanangur (Cheyyar taluk) villages of North Arcot district from February to April 1960. The incidence began in a mild form but built up to a heavy density of population by March; in April the population declined.

The insect is not an endemic one and the outbreak reported here is of a sporadic nature. From reports received it is gathered that a similar incidence occurred eight years ago and caused enormous loss to the cultivators.

TRIALS WITH INSECTICIDES

The incidence of the pest on a large scale was taken advantage of for testing insecticides for its control. Two fields of about one acre each were chosen and DDT 10% dust was applied in one and Parathion (Folidol) 0.025% (1 oz. in 12½ gallons of water) was sprayed in the other. The observations showed that the beetles flew away in large numbers from the DDT-dusted plots in a few hours. Birds like crows and sparrows preyed upon these beetles. In the field treated with Parathion the insects were not disturbed. However, in both the plots no beetles were found after three days. This suggests that both of the insecticides are able to control the pest.

ECONOMIC STATUS

C. tegetum is a perennial plant and gives cuttings of *Korai* culms every six months. The incidence of the Mat-grass Jewel Beetle a month or two after a cutting causes the culms to wilt and reduces the yield to about a fourth of its normal one. Hence, the insect has to be considered as a serious pest. However, it has so far been only a sporadic pest with heavy incidence occurring only occasionally.

ACKNOWLEDGEMENTS

The author wishes to express his grateful thanks and deep sense of gratitude to Dr. S. Kanakaraj David, Reader in Entomology, Post-Graduate Training Centre, Coimbatore, under whose valuable suggestions this material was prepared, and to Sri. P. P. Vasudeva Menon, Research Assistant in Entomology, for helping him in identifying the specimen.

POST-GRADUATE TRAINING CENTRE,
COIMBATORE, 3, A. ABDUL KAREEM
October 31, 1960.

19. BUTTERFLY NOTES FROM ASSAM : THE UNDESCRIBED FEMALE OF *YPTHIMA ATRA*

Ypthima atra Cantlie & Norman. The ♂ was described in the Journal, Vol. 56, No. 1, pp. 66-71. A single ♀ has now been taken by Norman at Kangpokpi (Manipur) on 5-10-58. This was caught a few miles from where the ♂♂ had been taken, at the same altitude and in the same type of country. It is described below:

Ypthima atra Cantlie & Norman—♀

The tiny ocellus above and below in space 2 of the fore wing, the grey ground colour below with no trace of yellow and the bipupilled ocellus at the tornus underhind are characteristics of *atra*. The ocelli underhind are, however, like those of *methora* in position, those in spaces 5 and 6 being close but not touching, likewise those in 2 and 3. The bipupilled ocellus at the tornus is not circular as in the previously taken ♂♂ of *atra*, but is like a figure of 8, exhibiting semi-fusion of two ocelli; and this ocellus is at the same distance from and in echelon with those in spaces 2 and 3, not in line with them.

This ♀ brings *atra* nearer to *methora*, although *methora* never has the tiny ocellus in space 2 of the fore wing, and the tornal ocelli underhind, although touching, are never, even partially, fused in the latter species.

SELENG T.E.,
SELENG HAT P.O.,
UPPER ASSAM,
February 22, 1961.

KEITH CANTLIE
T. NORMAN

20. A NEW FRUIT BORER PEST *RAPALA VARUNA* HORSFIELD (LEPIDOPTERA : LYCAENIDAE) ON GUAVA IN SOUTH INDIA[1]

INTRODUCTION

Of the several pests noted on Guava (*Psidium guajava* L.) those that attack the fruits are considered to be the most serious. The fruits are frequently infested with the maggots of the fruit flies *Dacus ferrugineus* F., *D. ferrugineus dorsalis*, and *D. zonatus*, and caterpillars of the castor capsule borer *Dichocrocis punctiferalis* Gr. and the pomegranate fruit borer *Virachola isocrates* F. (1 & 2). Tea blight *Helopeltis antonii* S., a reddish brown Mirid bug, commonly punctures the guava fruit and causes the 'blister disease' by making way for the entry of the fungi *Petalotiopsis* (*Pestalotia*) *psidii* and *Glomerella cingulatum* or *G. psidii* (1). Sometimes the fruit sucking moth *Ophideres fullonica* L. attacks the fruits at night; it pierces the fruit and sucks the sap, causing the fruit to rot around the puncture. Now, another caterpillar *Rapala varuna* H. has been found to cause damage to the fruits by boring into them. The insect was found in the trees in the Agricultural College and Research Institute, Coimbatore, during June-July. Since this is the first record of its occurrence on this host and as there is a possibility of its becoming a major pest in future, the observations made are given below.

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[1] Communicated by the Dean, Agricultural College & Research Institute, Coimbatore.

PREVIOUS RECORDS

Swinhoe (3) has recorded the larvae of *Rapala varuna* H. feeding on the flowers of *Zizyphus xylopyrus* Willd. Wynter-Blyth (4) also noted it, on the flowers of *Quisqualis indica* L., *Zizyphus rugosa* Lamk., *Z. xylopyrus* Willd., and *Sapindus laurifolius* Vahl (*trifoliatus* Linn.). It is also of much interest that the pest has been noted here feeding on guava fruits which deviates from its normal flower feeding habit.

THE LARVA

DESCRIPTION. Swinhoe (3) has described the larva similar to that of *R. schistacea* in shape and protuberances but the colour is 'green, with a curved diagonal line almost pure white, to each segment; the fifth segment is very dark green, in some cases almost black, forming a band'. About *R. schistacea* he says 'Larva when full grown, quite $\frac{3}{4}''$ in length; the anterior segment contractile; rather stout; of the usual onisciform shape—roundly cylindrical instead of flattened. Head globular, very small, retractile and, when protruded, singularly like that of tortoise. Outline from above, a hexagonal cylinder, very slightly narrowing towards the head; segmental folds deeply marked; the spiracular and sub-dorsal ridges very deeply serrated. The humps are sharply pyramidal. Of these there are two unbroken series on each side, one sub-dorsal and one spiracular. The sub-dorsal series consists of 8 humps, continuous from the third to tenth segment. The spiracular series consists of 11 humps, continuous from the third to the 13th segment. Each hump bears 2, 3 or 4 short brown hairs. The texture of the skin is soft, smooth and velvety.' The caterpillar taken here coincides with the characters given above, except that it is darker and more brown than green.

FOOD HABITS. The caterpillar bores into the guava fruit and eats the pulp from inside, rendering it unsuitable for consumption. Only mature, unripe fruits are attacked, and at times the damaged fruits fall down in numbers. Only one caterpillar is found in a fruit and the affected fruit shows a large hole on it indicating the presence of the pest.

It pupates in the fruit in the tunnel made by it. The pupa is brown with a dark brown median longitudinal line and many minute dark spots, measuring about 1-1.4 cm. in length, without much difference between the anterior and posterior ends.

DESCRIPTION OF THE BUTTERFLY

Rapala varuna H. is commonly known as the 'Indigo Flash'. Wynter-Blyth (4) describes it as follows: 'Male: above, dull shining dark blue, not blue shot, shading to dark border. Forewing. Female: above, pale shining steel blue, dark border. ♂♀: below, ground colour slaty brown, often with purple or greenish gloss, to almost white in dry season forms. Forewing discal bands white-edged on both sides and usually broad. Hindwing discal band generally curved and parallel to termen; bar end cell usually close to or touching discal band. Width of markings variable.'

ECONOMIC STATUS

So far the insect has been noted only in small numbers in a few trees in the College orchard and the Cotton Breeding Station. The affected fruits have only the outer rind left, the inner pulp being completely scooped out. Many fruits had dropped to the ground due to earlier attack. If the population increases it is bound to cause considerable loss to the cultivator.

ACKNOWLEDGEMENT

We are grateful to Dr. S. Kanakaraj David, Reader in Entomology, Post-Graduate Training Centre, Coimbatore, for valuable suggestions given in the preparation of this paper.

FACULTY OF ENTOMOLOGY,
POST-GRADUATE TRAINING CENTRE,
COIMBATORE, 3,
October 1, 1960.

S. JAYARAJ
A. ABDUL KAREEM
P. P. VASUDEVA MENON

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3. Swinhoe, Col. C. (1911-12): Lepidoptera Indica. Vol. 9. Rhopalocera., Family-Lycaenidae: 56-58, plate 718, figs. 1, 1a, 1b.

4. Wynter-Blyth, M. A. (1957): Butterflies of the Indian Region: 361, 363, 499, pl. 47. Bombay Natural History Society, Bombay.

21. A SKIPPER BUTTERFLY [*HASORA ALEXIS* (FABRICIUS)] CATCHES A SPIDER

It is not unusual for butterflies and other insects to be caught in spiders' webs. On July 21, 1960 an interesting phenomenon was observed in Ahwa, Surat Dangs. A skipper, the common Banded Awl, *Hasora alexis*, which is a member of the Hesperidae group of butterflies, caught a tiny white spider and was firmly clasping it with its six walking legs.

A teacher caught the skipper alive between his thumb and finger and then brought it to me for observation. The skipper was very reluctant to release the spider. Only when I started to drop both live specimens in the ether jar did the skipper drop the spider.

What is the explanation of this butterfly's behaviour? Have butterflies ever been known to prey upon spiders or other living animals?

AHWA, VIA BILIMORA,
DANGS DISTRICT,
GUJARAT STATE,
July 25, 1960.

E. M. SHULL

[Mr. H. G. Acharya to whom the spider was sent for identification states that it appears to be one of the Crab Spiders, Family Thomisidae, whose curious legs enable them to move sideways and backwards like crabs. These spiders hunt their prey without the aid of webs and are also known to change their colour to match the flowers on which they lie in wait to capture insects visiting the flowers. The mouth parts of a butterfly only permit it to suck nectar and other liquids and we cannot help feeling that Dr. Shull was mistaken. The spider might have attempted to catch the butterfly as they have been known to do or they might have got entangled with each other by accident—EDS.]

22. A CASE OF CANNIBALISM IN THE CATTLE-LEECH, *HIRUDINARIA GRANULOSA* (SAVIGNY)[1]

In November 1959 about 200 Cattle-leeches (*Hirudinaria granulosa*) were collected by us from a tank at Udipi (Mysore State) and kept in a glass jar containing fresh water for about three weeks. Later, while dissecting some of the specimens I was surprised to find in the crop of one of them (120 mm. long and 12 mm. broad) another leech of the same species. The latter (55 mm. long and 5.75 mm. in breadth) lay between the second and the eighth central chambers of the crop and was in a fresh condition.

As is generally known, leeches have their mouth adapted for sucking blood and can scarcely be expected to swallow solid food, not to speak of feeding upon another living leech presumably as active as themselves. As far as I have been able to ascertain, this is the first record of cannibalism in leeches.

Department of Zoology,
M.G.M. College,
Udipi (Mysore State),
April 6, 1960.

V. BALAKRISHNAN

[Harding & Moore in THE FAUNA OF BRITISH INDIA, HIRUDINEA, 1927, say on p. 114 'predaceous leeches destroy large numbers of worms, including other leeches . . .'.—Eds.]

23. THE SYSTEMATIC POSITION OF *ISOLAIMIUM* COBB, 1920 (NEMATODA), WITH A DESCRIPTION OF A NEW SPECIES[2]

(*With one plate*)

A few females and large numbers of juveniles of a species of *Isolaimium* Cobb, 1920, were collected from the soil of a jute field in 1954. Additional specimens, including males, were found in 1960 in soil around the roots of jute and groundnut at Government Experimental Farm, Tajgaon, and around the roots of pineapple at Aminbagh, Dacca. The species is new and is named *Isolaimium stictochroum.*

Measurements were made of specimens after gentle heat fixation in water. The type specimens, however, were first mounted in glycerine and then measured.

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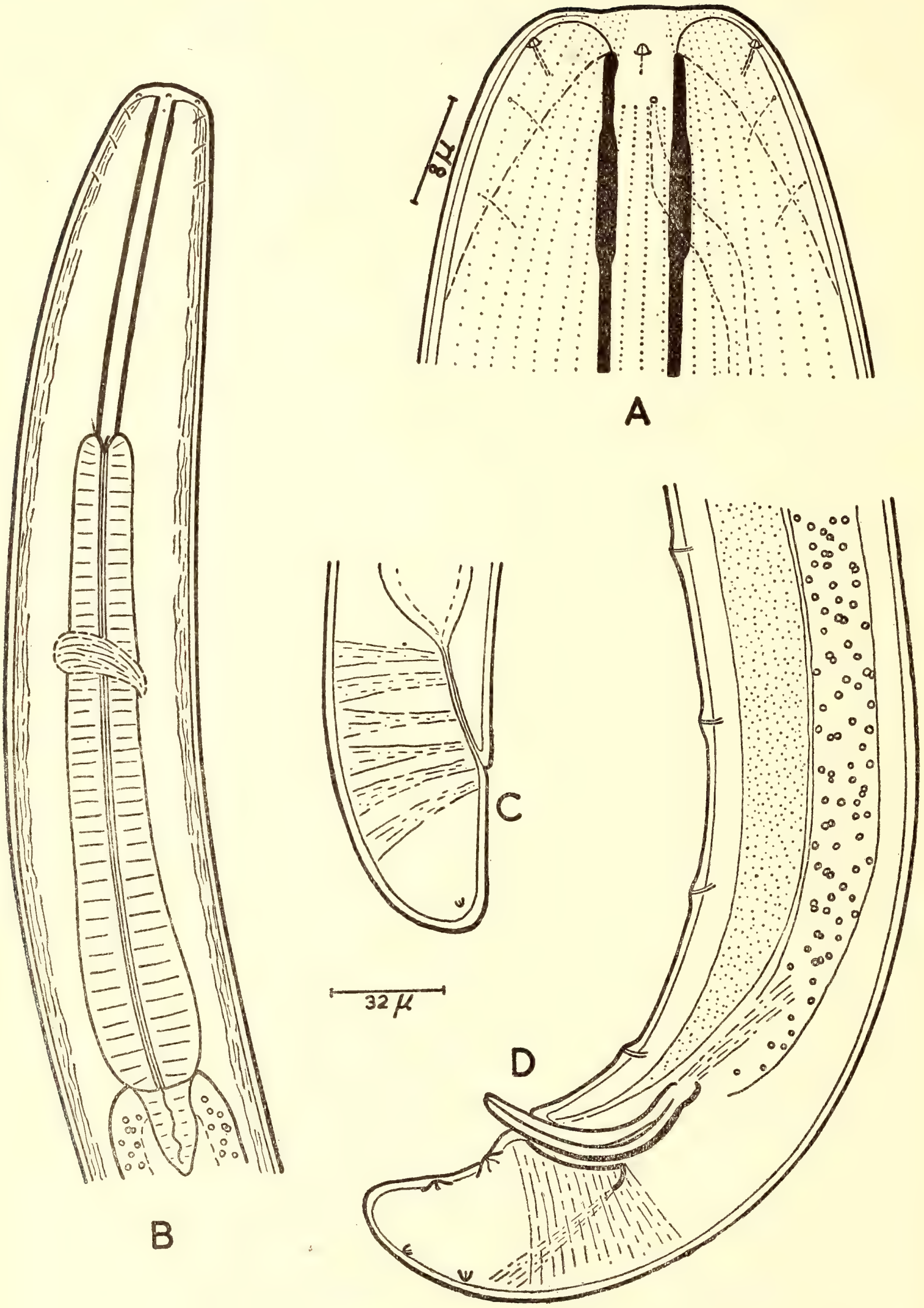
[1] Communicated by Dr. Beni Charan Mahendra, Dept. of Zoology, Agra College, Agra.

[2] Communicated by Rev. H. Santapau, S. J., Bombay.



Isolaimium stictochroum n. sp.

A. Male head; B. Oesophageal region; C. Female tail; D. Male tail.

Isolaimium stictochroum n. sp. (Plate A-D)

Measurements :

3 ♀♀ : Length=2.87-4. 62 mm. ; a=47.8-70 ; b=9-16 ; c=80-102 ; V=46.2-55.8% ; Ov1=11.2-13.2% ; Ov2=10.3-15.3%.

6 ♂♂ : Length=4.11-5.4 mm. ; a=60-76 ; b=12-20.1 ; c=77.6-106.

Holotype female : Length=4.23 mm. ; a=62.1 ; b=12 ; c=78 ; V=47.6%. Stoma 160 microns.

Allotype male : Length=3.6 mm. ; a=67 ; b=16.5 ; c=75. Stoma 150 microns.

The specific name is derived from the Greek words στικτός and Χρόος, meaning ‘ with spotted skin ’.

Description : Cuticle moderately thick, with two distinct layers visible ; fine close transverse striations in lower layer of cuticle ; prominent longitudinal lines on surface, about 60 in number, consisting of rows of fine dots, about 0.5 μ from centre to centre. Head not set off ; lips not distinct. Inner circle of 6 prominent, slightly recessed papillae, with distinct innervations ; outer circle of 4 tiny papillae. Fine sublateral innervations in anterior oesophageal region. Amphids tiny, pore-like, with obscure amphidial pouch twisting towards ventral side. Stoma cylindrical, with parallel walls, 108-160 μ long in male, 112-170 μ long in female ; walls thickened just behind anterior end ; apparently only thickened portion shed at moulting. Oesophageal region muscular, not distinctly two-part, extending to base of stoma ; expanded at base but not in form of distinct bulb ; triradiate lining heavily sclerotized and without expanded lumen at tips of radii. Oesophageal gland nuclei not observed. Nerve ring not prominent, oblique, located at about 50% of oesophageal length. Excretory cell and pore lacking. Oesophago-intestinal valve 22 μ long. Intestine with dark irregular granules, giving body a ‘ dirty ’ appearance ; intestine light and tessellated in specimens collected at end of dry season. Prerectum apparently absent. Female reproductive system amphidelphic ; ovaries reflexed ⅓ to ¼ their length ; oocytes not distinct ; ova brownish with clear shell, 65 × 30 μ. Two testes in male, outstretched. Spicules somewhat dorylaimoid, cephalated, with internal division and blunt tips, 54-67 μ long ; lateral pieces absent ; gubernaculum 16-28 μ long, with thin posterior apophysis. 3-4 mammillate preanal supplements, more or less uniformly distributed. Tail in both sexes subconoid, about 1 anal body diameter long, bent slightly ventrally. 4 pairs postanal papillae on male tail : 1 large subventral pair just behind anus, 1 small subventral pair at mid-tail ; 1 small subdorsal pair at mid-tail, and 1 small subdorsal or lateral pair on posterior half of tail. Postanal papillae less distinct in female. Diagnosis : The present species differs from *Isolaimium papillatum* Cobb, 1920, the type and only other described species, mainly in the following characteristics : (1) the cuticle bears prominent longitudinal striations, as opposed to the naked cuticle of *I. papillatum* ; (2)

the male has 3-4 preanal supplements, whereas the male of *I. papillatum* has 6 supplements.

Holotype female : Personal collection, No. S 11.

Allotype male : No. S 12.

Paratypes (male and female) : No. S 13 and S 14.

Type habitat : Soil around roots of jute (*Corchorus capsularis* L.).

Type locality : Government Experimental Farm, Tajgaon, Dacca, East Pakistan.

Discussion : Cobb (1920) gave sketches of only the extreme anterior and posterior of *Isolaimium papillatum.* Since he could not clearly distinguish the amphids, the systematic position of the genus has been in great doubt. Cobb himself classified it in the Order Isolaimia ; however, other authors have not followed Cobb's classification into orders and it does not correspond even roughly to the current classifications. Filipjev and Schuurmans Stekhoven (1941) included *Isolaimium* as an aberrant genus of the Mermithidae, but the oesophagus and intestine are completely different from the true mermithids. T. Goodey (1951) placed it questionably in the Family Axonolaimidae, Subfamily Cylindrolaiminae, stating that the systematic position is ' rather obscure owing to lack of detailed information on form and structure '.

Another possible placement for the genus, based chiefly on the long cylindrical stoma and the oesophagus, is in the Subfamily Cryptonchinae of the Family Ironidae. However, it seems best to propose *Isolaimium* as an aberrant genus of the Superfamily Dorylaimoidea. The thickened triradiate oesophageal lining, the oesophago-intestinal valve, the male supplements, the spicules, and the caudal papillae are all basically of the dorylaimoid type. The large size of the body, the short blunt tails, and the lack of an excretory cell and pore further strengthen this affinity. On the other hand, the amphids, which are an important diagnostic feature in classification, are not dorylaimoid. Pore-like amphids, however, occasionally appear in various groups by way of exception to the normal type. The greatest difference between *Isolaimium* and the typical members of the Dorylaimoidea is the lack of a stylet. In one moulting specimen that we observed, apparently only the thickened anterior portion of the stoma was being shed. This might correspond to the axial stylet of most dorylaimoids or to the vestibule of those forms possessing a mural stylet. Moreover, the Alaimidae, considered by many authors as a family of the Dorylaimoidea, completely lack both stylet and stoma.

NOTRE DAME COLLEGE,
DACCA, EAST PAKISTAN,
September 17, 1960.

R. W. TIMM

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24. *MOMORDICA DENUDATA* CLARKE (CUCURBITAC.) AND *TREMA POLITORIA* PLANCH. (ULMAC.): NEW RECORDS FOR BOMBAY

In our exploration of Pavagadh Hill, 46.6 km. NE. of Baroda, we have come across *Momordica denudata* and *Trema politoria* which are not listed in Cooke's FLORA OF THE PRESIDENCY OF BOMBAY.

Momordica denudata (Thwait.) Clarke in FBI. 2: 618, 1879; Cogn. in DC. Monog. Phan. 3: 448; Trimen, Fl. Ceyl. 2: 249; Chakravarty, Mon. Ind. Cucur. 98, f. 40, map 47, 1959.

M. dioica var. *denudata* Thwait. Enum. Pl. Zeyl. 126, 1858-64.

A slender climber; stem glabrous, furrowed. Tendrils slender. Leave 7-8×6-6.5 cm., membranaceous, ovate-cordate, mucronate-acuminate, dentate, slightly rough to the touch, some of the leaves appear to be three-lobed, 5-nerved, petiole 3-4 cm. long. Flowers yellowish, dioecious. Male peduncle many-flowered. Female peduncle 1-flowered, 1-2 cm. long. Fruit slightly globose, rostrate.

Flowering and Fruiting: 12th July 1959.

At the foot of the hill on a hedge; rare.

Index Kewensis gives Ceylon as the home of this plant. The plant seems to be endemic in S. India.

Trema politoria Planch. in Ann. Sc. Nat. (ser. 3) 10: 326, 1848; FBI. 5: 484.

Celtis politoria Wall. Cat. no. 3693, *nom. nud.*

A small tree; bark brownish, branches clothed with rough hairs. Leaves 4-5×2.5-2.7 cm., stipulate, 3-4-nerved, alternate, oblique, presence of bristly hairs, ovate, minutely cordate, serrate, petiole 2-3 mm. long. Flowers in axillary cymes, compact, not longer than the petiole.

Flowering and Leafing: 12th August 1958.

In the forest, in lower part of the hill; rare.

Index Kewensis gives Reg. Himal. as the home of this plant.

The specimens referred to in the present note were collected by the junior author from Pavagadh and are preserved in the Herbarium, Department of Botany, M.S. University of Baroda.

These two plants have not been recorded from Bombay. They are, therefore, new records for Bombay.

ACKNOWLEDGEMENTS

We record our sense of gratitude to Shri M. B. Raizada, F.N.I., Forest Research Institute, Dehra Dun, and to the late Dr. D. Chatterjee of Indian Botanic Garden, Calcutta, for helping in the identification.

DEPARTMENT OF BOTANY,
M.S. UNIVERSITY OF BARODA,
BARODA,
December 31, 1960.

A. R. CHAVAN
G. M. OZA

25. PLANT NOTES FROM ASSAM : *MERREMIA TUBEROSA*, AND BAMBOO FRUITS

I was very interested to read Dr. Chatterjee's notes on these two subjects, published in the August issue of the *Journal.*

A shaded plant house is rarely seen in Assam, but for many years past *Merremia tuberosa* has been grown here as a shade creeper for bungalows, hospitals and factories. It is usually grown on wire or bamboo supports beside walls with a southern aspect, where it forms a dense mat, lowering the temperature inside the building very appreciably. It can also be allowed to grow over the roof with equally good effect, but it is too heavy to be perfect for this purpose, requiring to be cut back at least every third year. *M. tuberosa* and *Ipomoea palmata* (the Railway Creeper) thrive well together, and since they flower at the same time pleasure can be combined with utility by having a mixed planting, resulting in a most pleasing display of colour.

I feel that I must also add a few observations of my own to Dr. Chatterjee's most interesting article on the fruiting of the *mooli* bamboo. This bamboo has been fruiting in the wild state at least since the cold weather of 1952/53, in the hills of South Manipur near the Lotchow River. It would be interesting to know whether the year of peak fruiting there coincided with the 1959/60 peak in the Assam Valley.

The *kaka* bamboo flowered, fruited and died in the forests of Assam during the early 'fifties, the peak year having been preceded by at least one year of sporadic flowering. Last cold weather (1959/60) a few clumps of the *jathi* bamboo flowered and fruited in Sibsagar District. Only a few culms of a very small proportion (perhaps 5%) of the clumps flowered, but I think one can confidently predict that within the next 5 years—and probably wihin the next 2 years—the *jathi* bamboos throughout the Assam Valley will flower and die. Since the *jathi* is the species most widely cultivated in the Valley, and since I would expect it to be relatively slow growing from seed (unlike the *mooli*), its flowering will be a grave economic and social disaster.

SELENG T. E.,
SELENG HAT P.O., T. NORMAN
UPPER ASSAM,
January 29, 1961.

26. CRITICAL NOTES ON *ACER CAMPBELLII* HIERN

(*With one plate*)

Acer campbellii is described by Hiern in Hooker's FLORA OF BRITISH INDIA **1** : 696, 1875. Prior to this, Brandis in FOREST FLORA : 109, 1874, merely mentioned the name; hence *A. campbellii*, as there, is a *nomen nudum*, and we disregard that publication. On this account Hiern's name is to be considered as the original publication of the species. But the description offered by Hiern covers a wide range.

From a study of the material housed in the Central National Herbarium, Calcutta (CAL)* and Forest Herbarium at Dehra Dun (DD)* and my own collections from east Nepal, two varieties can be recognised. Thus, necessary information and opinion was sought from Arnold Arboretum and Kew. Dr. S. Y. Hu of the Arnold Arboretum agreed with me after examining my specimens collected in east Nepal as to the two different entities and informed me also that the type material of *A. campbellii* is a mixture of two collections as is borne out by the material in the Herbarium Hookerianum and that in the Gray Herbarium of the Harvard University.

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* Symbols as in Lanjou & Stafleu, Index Herbariorum, Pt. I, ed. 3, 1956.

Mr. C. E. Hubbard of Kew replied to my enquiry saying that the material written up by Thomson as '*Acer campbellii* Hk. f. & Th.' consists of five sheets of Hooker's, but added 'While our material seems to have the full range of the variations described by you, it has not been found possible to distinguish the varieties which you propose'.

The material available in Indian herbaria was again critically studied and plants in nature were closely studied. It became very convincing that the entire material can be sorted out into two clearly demarcated varieties. It, thus, involved the selection of a lectotype for *A. campbellii* and to delimit the characters for the var. *campbellii.* By kindness of Mr. Hubbard, this was made possible. Thus:

Acer campbellii var. **campbellii** Hk. f. & Th. ex Hiern in Hooker, Fl. Brit. Ind. **1** : 696, 1875, emend. Banerji. *Acer campbellii* Hk. f. & Th. ex Hiern in Hooker, Fl. Brit. Ind. 1 : 696, 1875.

Lamina foliorum truncata ad basim, marginibus serrulatis, nervis glabris; inflorescentia densa.

Lectotypus: *Hooker f.* 110, lectus ad Darjeeling ad 7-8000 ped. altit. servatus in Herbario Kew.

Representative specimens. SIKKIM: Sikkim, 7-10,000 ft. Hooker (CAL); Sinchul 8000 ft. Anderson 408, July 1862 (CAL); Darjeeling 7000 ft. Clarke 26737, 19 June 1875 (CAL); Tongloo, Lister, May 1877 (CAL); Sandakphu, King's collector, June 1887 (CAL); Darjeeling, Griffith 926 (CAL); Darjelling-Takda, Lace 2201, 10th May 1902 (CAL); Suriel 5500 ft. Cousin 112, 29th May 1914 (CAL); Sikkim, Biswas 81 (CAL); Darjeeling (DD 85298). Sinchul, Anon. (DD 39198); Kurseong, Anon. (DD 19247).

NEPAL: Papung to Topke Gola 9000 ft. Banerji 774 (CAL. BLAT, GH, & Meerut).

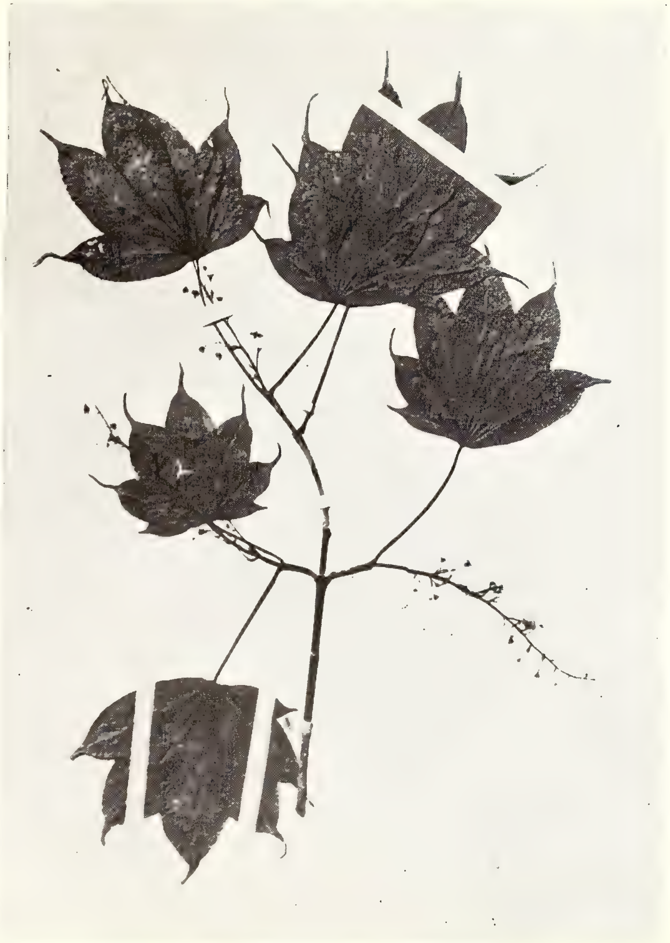
Acer campbellii Hk. f. & Th. ex Hiern var. **serratifolia** Banerji, var. nov.

Folia majora, cordata ad basim, serrata ad margines, saepe bis serrata, pubescentia ad nervos in pagina ventrali; inflorescentia elongata.

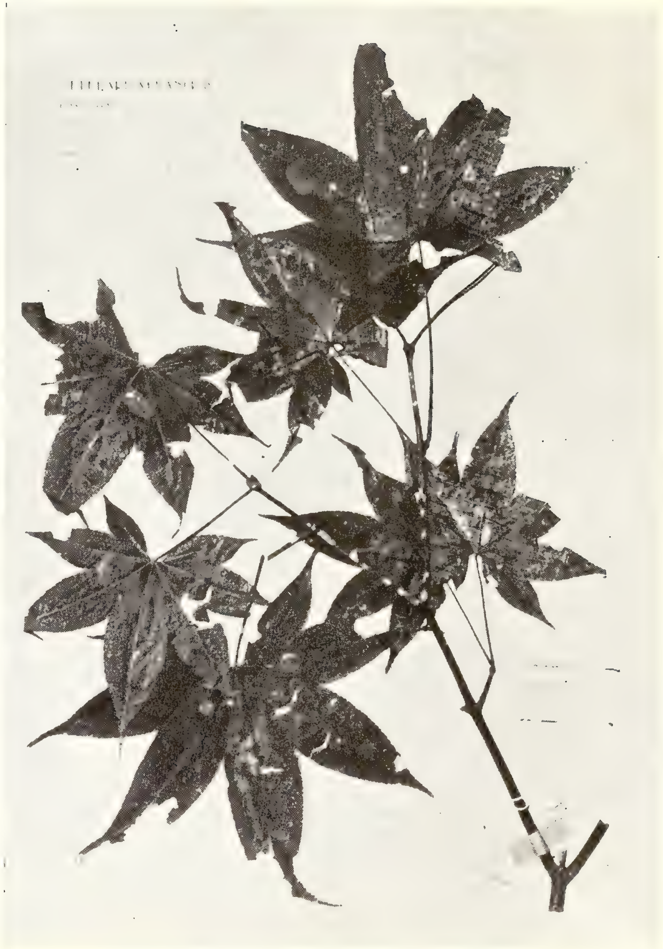
Typus: *Lace* 2250, lectus ad Tonglo in Sikkim ad 10,000 ped. altit. die 29 maii, anni 1902 et positus in Herbario Hortus indici Botanici ad Calcutta.

Representative specimens. SIKKIM: Sikkim, Dungboo 22nd May 1876 (DD); Lachen, Pantling, May 1885 (CAL); Darjeeling—Bhikabhanjan 10,000 ft. Osmaston 20th October 1903 (CAL).

NEPAL: Lamjura 12,000 ft. Banerji 1064, 20th September 1956



Acer campbellii var. *campbellii*



Acer campbellii var. *serratifolia* var. nov.

(CAL, BLAT, GH, & Meerut), Kalinchok to Rowlkhani (western face) 10,000 ft. Banerji 1259, 13th October 1960 (GH & Meerut).

It may be mentioned that unfortunately neither the Lace collection nor any of the other specimens mentioned under var. *serratifolia* are at Kew. Also the materials collected from east Nepal are different from the specimens of the closely related Chinese species or varieties that have been examined at the Arnold Arboretum and Gray Herbarium. It is evident from the distribution of the two varieties that they are restricted to Sikkim and extend westwards to east Nepal. Intensive exploration of Nepal will show the further westward extension of the species and its varieties.

It is due to the kindness and help rendered by Dr. S. Y. Hu and Mr. C. E. Hubbard that it has been possible to work out the material and prepare this note. To Rev. Fr. H. Santapau I am deeply indebted for having gone through the paper and made improvements.

BOTANY DEPARTMENT,
MEERUT COLLEGE,
MEERUT,
November 15, 1960.

M. L. BANERJI

27. ON THE STRUCTURE AND LIFE-HISTORY OF A NEW SPECIES OF *ANABAENA* (*A. DESIKACHARYENSIS*) FROM HOSHIARPUR (PANJAB, INDIA)

(*With four text-figures*)

During the course of a systematic investigation of the Cyanophyceae of Hoshiarpur (Panjab, India) the author came across a new species of *Anabaena*, which was found growing in the gelatinous thallus of *Aphanothece pallida* (Kütz.) Rabenh., on the 1st September, 1960. It is described below.

GENERAL MORPHOLOGY

The trichomes occur singly or in clusters within the gelatinous thallus of *Aphanothece pallida*. An indistinct sheath is sometimes discernible around individual trichomes. The trichomes are irregularly curved sometimes coiled but never straight and are slightly attenuated at the ends (Fig. 1). The cells are usually barrel-shaped, 5.1-5.7 μ broad and 5.1-6.8 μ long. The trichome is distinctly constricted at the septa. There is also an indication of the absence of cell sheath opposite the septa so that the latter are only composed of the inner investment. The cell sheath stains blue with iodine and sulphuric acid. The end cell is conical. The cells are full of cyanophycin granules.

The heterocysts are usually intercalary but terminal heterocysts are also of common occurrence and may be present on one or both the sides of the trichome (Fig. 1). They are conical in shape. The intercalary heterocysts are often spherical and sometimes barrel-shaped. The ends are rounded. They are 5.7-6.8 μ broad and as long as broad. The contents are homogenous and pale blue.

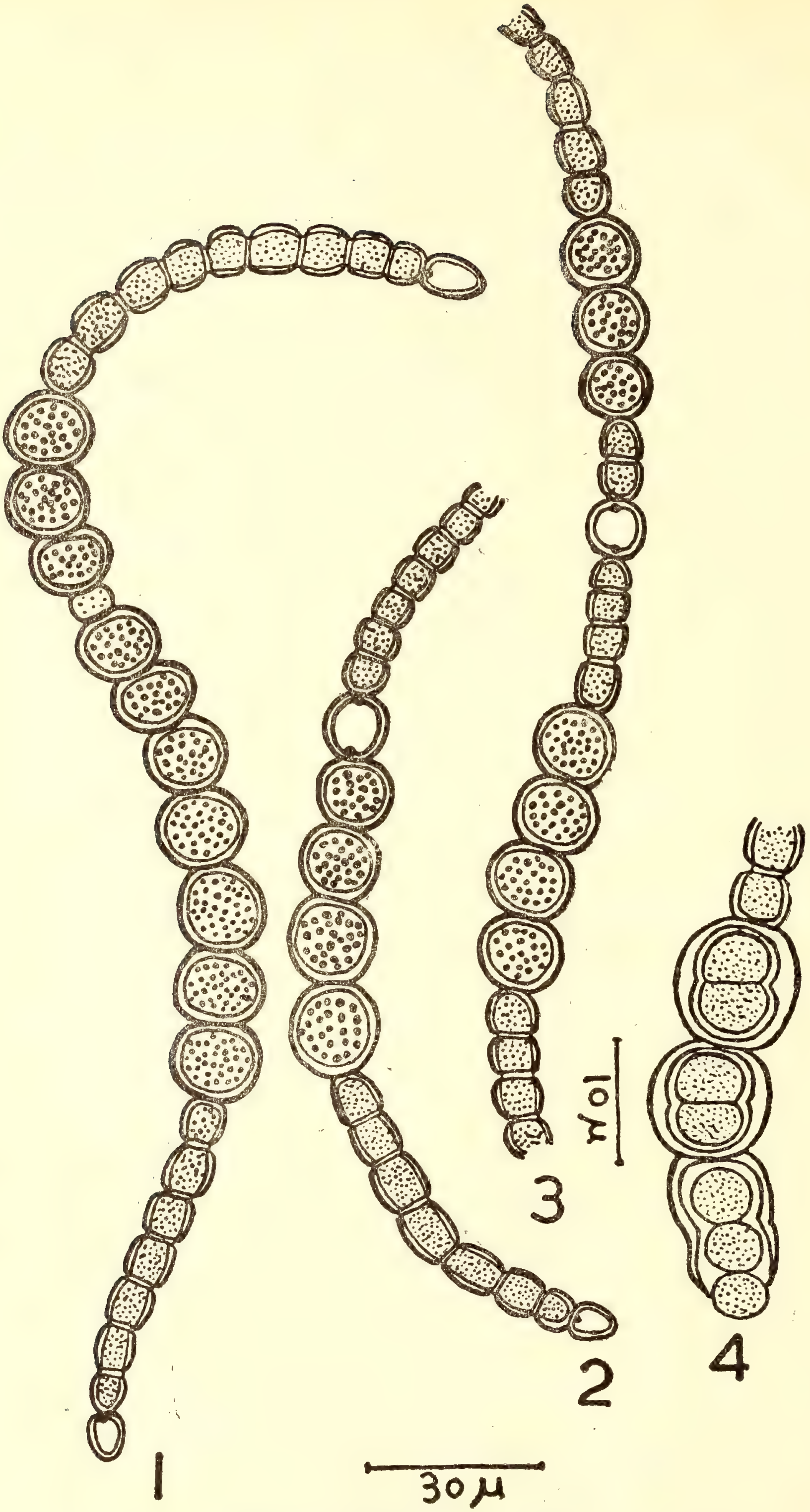
The akinete formation is marked by the enlargement of the cells and by the appearance of large number of cyanophycin granules. The cell sheath becomes thickened and closes over the ends to form a spherical akinete. Usually the akinetes are away from the heterocysts (Fig. 2) but sometimes they may be contiguous to the intercalary heterocysts (Fig. 3). In the latter case the akinetes are present only on one side of the heterocyst and are usually in short chains of two to six. Sometimes the chains of akinetes are interrupted by an ordinary vegetative cell (Fig. 1) which may later on shrivel up and die. The outer wall of the akinete is thick and yellowish brown in colour. They are 8.5-11.5 μ in diameter.

GERMINATION OF THE AKINETE

The akinetes have been observed to germinate *in situ* (Fig. 4). Before germination the contents of the akinete may slightly contract from the wall and sometimes the akinete may even elongate and show an apparent constriction in the middle owing to differential gelatinisation. The contents undergo a transverse division to form a two-celled germling. The germlings are released by the gelatinisation of the spore wall at one end. By further division this germling grows into a full-fledged trichome.

SYSTEMATIC POSITION

The Hoshiarpur alga in its variable position of the akinetes resembles *Anabaena werneri* Brünn., *Anabaena scheremetievi* Elenk., *Anabaena planktonica* Brünn. and *Anabaena randhawae* Venketaraman. It differs from the first in the absence of pseudovacuoles and the presence of terminal heterocysts. It comes away from *A. scheremetievi* in possessing irregularly curved trichomes, absence of ellipsoidal akinetes and in the absence of a broad mucilaginous sheath. *A. planktonica* differs from it in possessing smaller dimensions of the cells and in the absence of terminal heterocysts. The present species resembles *A. randhawae* in the presence of terminal heterocysts and in the variable position of the akinetes ; but differs from it in possessing (*a*) broader trichomes that are



Anabaena desikacharyensis sp. nov.

Fig. 1. A trichome showing conical terminal heterocysts at both the ends. A vegetative cell is also shown intervening in the chain of spores; Fig. 2. A portion of a trichome showing a chain of spores contiguous to the intercalary heterocyst; Fig. 3. A portion of the trichome showing short chains of spores remote from the heterocyst; Fig. 4. Showing germination of the spores.

irregularly curved, (*b*) terminal heterocysts conical and present on both sides of the trichome, and (*c*) in the greater dimensions of the spores. Formation of terminal heterocysts brings this species away from *A. sphaerica, A. spiroides, A. gelatinicola,* and *A. anomala.* The shape of the terminal heterocyst and the attenuation of the trichome bring this species closer to *A. oryzae* Fritsch ; but it differs from it in the following respects : (*a*) broader trichomes, (*b*) the akinetes are broader, and (*c*) the akinetes are never contiguous to the terminal heterocysts. It differs from all the above species in its endophytic habit.

The present species may, therefore, be regarded as a new species and the author takes great pleasure in naming it after Dr. T. V. Desikachary of the Madras University for his valuable contributions in the field of algology.

DIAGNOSIS

Anabaena desikacharyensis sp. nov. (Figs. 1-4)

Trichomata irregulariter curvata, attenuata ad apices, endophytica ; cellulae doliiformes, 5.1-5.7 μ latae et 5.1-6.8 μ longae; heterocysta intercalaria vel terminalia, intercalaria quidem sphaerica vel doliiformia, 5.7-6.8 μ lata et 5.7-6.8 μ longa ; terminalia vero conica, 5.1 μ lata et 6.8 μ longa, adstantia ad unum vel ad utrumque latus trichomatis ; akinetes sphaerici, ut plurimum remoti ab heterocystis, nonnumquam heterocystis intercalaribus contigui, 8.5-11.5 μ diam., parietibus externis luteo-brunneis.

Habitus endophyticus in thallo mucilaginoso *Aphanotheces pallidae* ; crescit in solo madido in collegio Gubernii ad Hoshiarpur, lectus mense septembri, anni 1960. Typus positus in herbario Hoshiarpur sub numero *Vasishta* 4332.

Trichomes irregularly curved, attenuated at the ends ; endophytic cells barrel-shaped, 5.1-5.7 μ broad and 5.1-6.8 μ long; heterocysts intercalary or terminal, intercalary heterocysts spherical or barrel-shaped, 5.7-6.8 μ broad and as long as broad; terminal heterocysts conical, 5.1 μ broad and 6.8 μ long, present on one or either side of the trichome ; akinetes spherical, usually remote from the heterocysts, sometimes contiguous to the intercalary heterocyst, 8.5-11.5 μ in diameter, outer wall yellowish brown.

Habitat : Endophytic in the gelatinous thallus of *Aphanothece pallida* (Kütz.) Rabenh. ; collected from the moist floor of a pavement in Government College, Hoshiarpur on September 1, 1960.

Type of the species is deposited in the Government College, Hoshiarpur herbarium under reference number *Vasishta* 4332.

ACKNOWLEDGEMENTS

The author is extremely grateful to Dr. T. V. Desikachary for going through the manuscript and giving useful suggestions and for approving the new species. His grateful thanks are also due to Prof. Rev. Fr. Santapau, St. Xavier's College, Bombay, for kindly rendering the diagnosis into Latin.

DEPARTMENT OF BOTANY,
GOVERNMENT COLLEGE, HOSHIARPUR,
December 14, 1960.

P. C. VASISHTA

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28. NEW RECORDS OF PLANTS FROM THE ANDAMAN AND NICOBAR ISLANDS

(*With three text-figures*)

INTRODUCTION

A botanical exploration tour to the Andaman and Nicobar Islands was conducted by the Botanical Survey of India during January to April, 1959. A careful scrutiny of the past literature dealing with the vegetation of the above islands, as well as the specimens from these islands present in the Central National Herbarium was made, as a result of which the following species are noted as new records in their flora. Some of the new records are either Malayan or Burmese of origin. A short description of the newly recorded species together with features of interest if any, as well as their exact locality is given below. The two groups of islands are treated as one unit for purpose of deciding new records.

BIXACEAE

1. **Scolopia spinosa** (Roxb.) Warb. *Scolopia roxburghii* Clos, F. B. I. 1 : 190.

A spreading shrub growing to a height of 5 m. Flowers cream white in colour, with a good scent. Artican, Sawai, Car Nicobar, rare, in flower (31-3-1959), *Thothathri* 9353. One specimen of the above species from Burma is present in the Calcutta Herbarium (*Helfer* 211), but the label bears distribution Tenasserim and Andamans. This

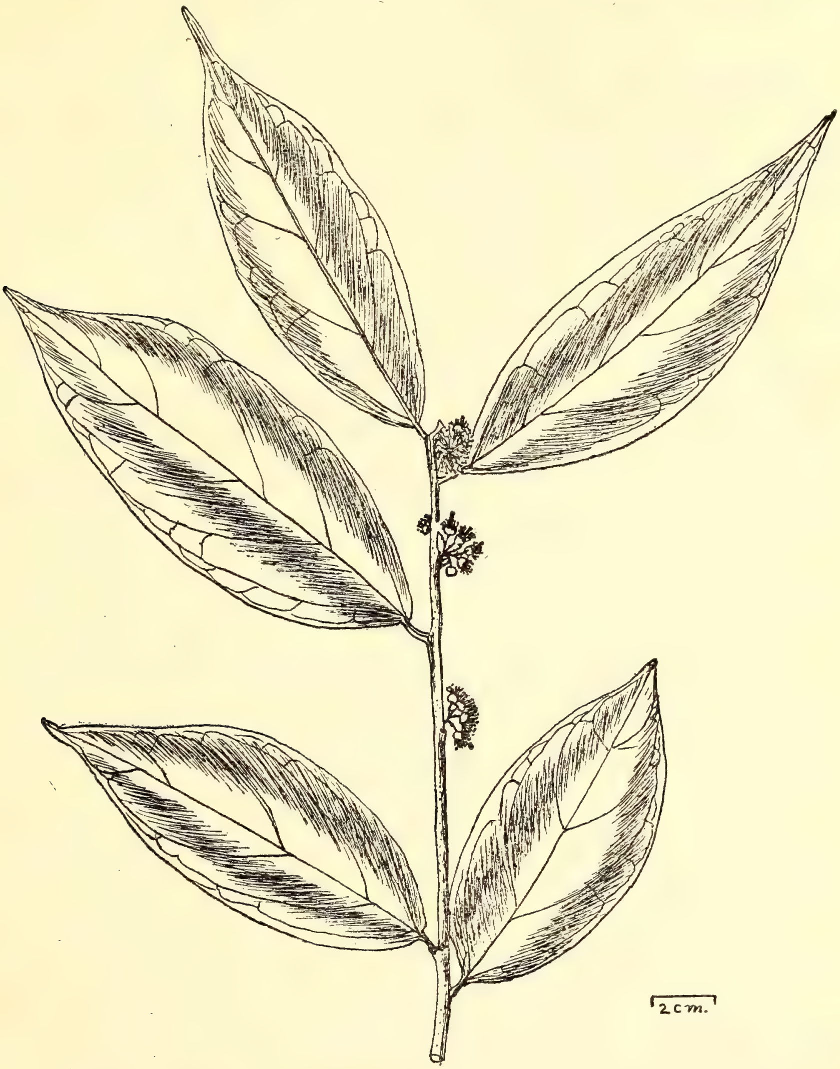

FIG. 1 SCOLOPIA SPINOSA (Roxb.) Warb.

specimen is kept along with similar Burmese specimens in the same cover. Most of Helfer's collections from Tenasserim bear similar labels. So it is highly doubtful whether this specimen (*Helfer* 211) was collected at all from the Andamans.

Distribution: Sumatra, Burma and Nicobar Is.

SAMYDACEAE

2. **Casearia glomerata** Roxb.

A small tree reaching a height of 8 m. with spreading branches, growing in sandy and clayey soil. Flowers white. Kimios, Car Nicobar, rare, in flower and fruit (27-3-1959). *Thothathri* 9332.

Distribution: *India*: Sikkim, Bhutan and Khasia. *World*: Hong Kong and probably Malayan Peninsula.

3. **Casearia tomentosa** Roxb.

A small tree growing to a height of 7 m. in sandy soil. Flowers yellowish green. Leaves and younger parts tomentose. Chaibagan, South Andaman, common, in flower (4-3-1959). *Thothathri* 9248, 9260.

Distribution: *India*: Throughout India. *World*: Ceylon, Malaya and North Australia.

ASCLEPIADACEAE

4. **Marsdenia volubilis** (Linn. f.) Cooke. *Dregea volubilis* Benth. ex Hk. f. F. B. I. 4: 46.

A twining shrub in the beach forest of Car Nicobar. Mus Jetty. Car Nicobar, rare, in flower (28-3-1959). *Thothathri* 9342.

Distribution: *India*: Bengal, Assam, and southern and western India; common in plains and hills up to 5000 feet in dry regions. *World*: Ceylon and Java.

5. **Tylophora indica** (Burm. f.) Merr. *Tylophora asthmatica* W. & A., F. B. I. 4: 44.

A twining shrub growing in sandy soil. Kimios, Car Nicobar, common, in flower (27-3-1959). *Thothathri* 9333.

Distribution: *India*: Bengal, Assam, Cachar, Chittagong and southern and western India; common throughout the plains in hedges and open forests, up to about 3000 feet in hilly country. *World*: Burma, Siam, Malaya Islands and Borneo.

GENTIANACEAE

6. **Canscora diffusa** R. Br.

An erect slender, dichotomously branched herb growing by the side of a small stream in North Andaman. Flowers pink. Taralait Bay, North Andaman, common, in flower (8-2-1959). *Thothathri* 9196.

It is to be pointed out here that one specimen of the above species (*Helfer* 5815) present in the Calcutta Herbarium bears a label with the distribution data as Tenasserim and Andamans; no definite information on the exact locality of collection was given.

Distribution: *India*: Throughout India ascending up to 1000 m., common from Kumaon and Bhutan to southern India. *World*: Ceylon, Malaya, Australia and Tropical Africa.

ACANTHACEAE

7. **Lepidagathis incurva** D. Dunn. *L. hyalina* Nees., F. B. I. 4: 521.

A small under-shrub found growing in the forest floor, under the shade of shrubs in North Andaman. Austin II, North Andaman, common, in flower (1-2-1959), *Thothathri* 9156.

As in previous cases, *Helfer* 6137 present in the Calcutta Herbarium bears a label with distribution data as Tenasserim and Andamans. The specimen is however placed along with similar Burmese specimens in the same cover.

Distribution: *India*: Throughout North India up to 1000 m., Jammu to Upper Assam and Chittagong, Bihar and Chota Nagpur and Madras Presidency. World: Burma and China.

8. **Staurogyne zeylanica** O. Kze.

A small herb up to 10 cm., common in the forest floor of North Andaman. Austin II, North Andaman, common, in flower (1-2-1959). *Thothathri* 9160.

A specimen collected by Kurz from South Andaman was identified as *Staurogyne glauca* O. Kze. Clarke has remarked on this sheet that it may be *Staurogyne zeylanica* O. Kze. On careful examination, Clarke's identification proved correct and our species is *Staurogyne zeylanica* O. Kze.

Distribution: *India*: Khasia Hills, North Sylhet, Deccan and western India. *World*: Ceylon.

LABIATAE

9. **Hyptis capitata** Jacq.

An erect herb growing in moist clayey soil. Port Blair, South Andaman, common, in flower (12-1-1959). *Thothathri* 9038.

Distribution: *India*: Lower Bengal. *World*: America, Formosa and the Philippines.

PROTEACEAE

10. **Helicia serrata** (R. Br.) Bl. *H. crutisii* Gamble, F. M. P. 142.

A shrubby plant growing to a height of 3-4 m. in sandy loam. Flowers are cream yellow in colour. On the way to Taralait Bay

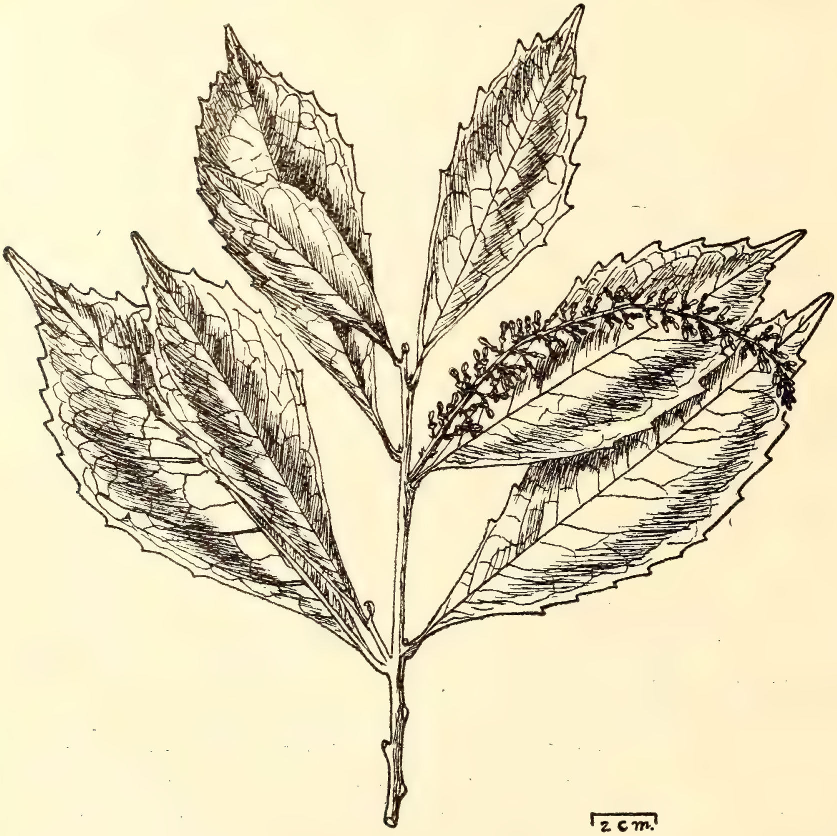

FIG 2 HELICIA SERRATA (R.Br.) Blume.

from Mangrove Bay, North Andaman, rare, in flower (7-2-1959). *Thothathri* 9186.

Distribution: Malaya.

ORCHIDACEAE

11. **Aërides radicosum** A. Rich.

A beautiful epiphytic orchid. Flowers pink without any scent. Lapati jungle, Car Nicobar, rare, in flower (26-3-1959). *Thothathri* 9324.

Distribution: Deccan plateau, Nilgiri and Pulney hills, Quilon and Western Ghats.

12. **Dendrobium pierardi** Roxb.

An epiphytic orchid. Flowers prominent, yellowish white and sweet scented. Chaoldari, South Andaman, common, in flower (26-3-1959). *Thothathri* 9237.

Distribution: *India*: Eastern Tropical Himalayas, Sikkim, Sundarbans in Bengal, Coromandel and Coorg. *World*: Burma.

POLYPODIACEAE

13. **Pyrrosia longifolia** (Burm.) Morton. *Niphobolus acrostichoides* Rich.; Bedd. Handb. 327.

An epiphytic fern found growing in association with *Asplenium nidus* Linn., *Vittaria elongata* Sw., and *Phymatodes scolopendria* (Burm.) Ching., on the branches of small trees in the beach forests of Car Nicobar. The rhizome is clothed with ovate to ovate-lanceolate, reddish brown scales. Mus Jungle, Car Nicobar, common, in sori (28-3-1959). *Thothathri* 9344.

Distribution: Malaysia to Queensland and Polynesia.

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The author expresses his sincere thanks to Dr. S. K. Mukerjee, Keeper, Central National Herbarium for kindly going through the paper and making valuable suggestions, and to Dr. J. C. Sen Gupta,

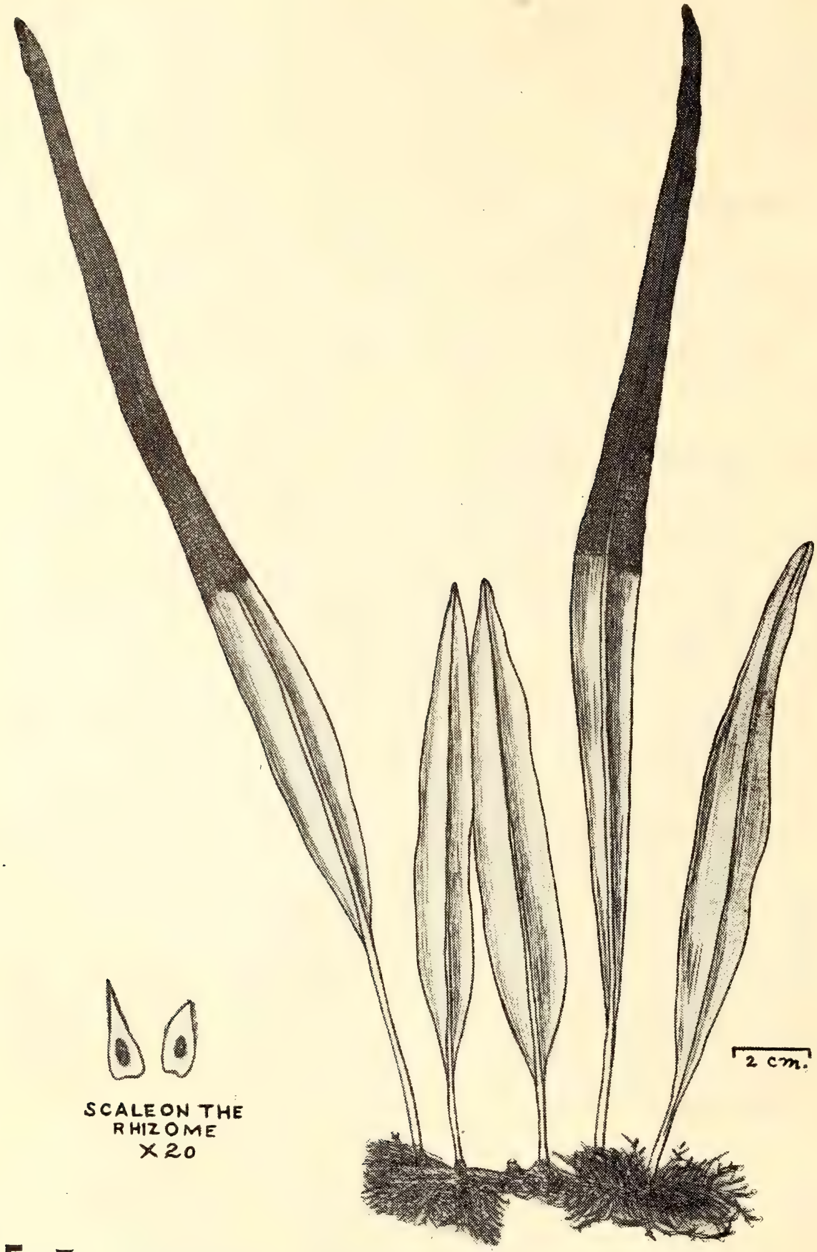
SCALE ON THE RHIZOME X20
2 cm.

FIG 3 PYRROSIA LONGIFOLIA (Burm.) Morton

Chief Botanist, Botanical Survey of India, for the kind encouragement shown in the above work.

CENTRAL NATIONAL HERBARIUM,
BOTANICAL SURVEY OF INDIA,
INDIAN BOTANIC GARDEN, SHIBPORE,
CALCUTTA,
January 16, 1961.

K. THOTHATHRI

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29. A NEW GRASS FROM BOMBAY

Coelachne minuta Bor sp. nov. ab aliis speciebus hujus generis panicula laxa, spiculis mioribus, statura humili, foliorum laminis ovato-acutis distincta.

Gramen annuum delicatulum. *Culmi*, panicula inclusa, usque 8 cm. alti, vaginis obtecti, glabri levesque. *Foliorum laminae* ovato-acuminatae, planae, supra infraque nervis scaberulae, supra pilis sparsis praeditae, marginibus scabrae; vaginae culmos arcte complectentes, gabrae levesque; ligula ad seriem pilorum brevium redacta.

Panicula erecta, effusa, paucispiculata, usque 5 cm. longa, 2.5 cm. lata. *Spiculae* biflorae, 1.5 mm. longae, pedicellatae. *Gluma* inferior 0.25 mm. longa, orbicularis vel late elliptica, apici truncata, enervia, dorso glabra superior 0.5 mm. longa, elliptico-orbicularis, 1-2-nervia, glabra levisque. *Anthoecium inferius* hermaphrod.; lemma 1.25 mm. longum, dorso inferiori parte piloso, late ellipticum, truncatum, enervium; palea hyalina, 2-nervia; stamina 2; antherae 0.5 mm. longae; rhachillae articulus 0.5-1 mm. longus. *Anthoecium superius* vacuum vel ♀;

lemma elliptico-acutum, hyalinum, enervium; palea hyalina, 2-nervia, bicarinata; rhachilla haud producta; caryopsis ellipsoidea; embryo caryopsidis tertiae parti aequans; hilum punctiforme.

Bombay: Mahableshwar, 14-9-58, *H. Santapau* 22731; on rocky very moist ground, rare. Typus in Herb. Kew.

This specimen is quite unlike anything hitherto described in this genus. It resembles a specimen no. 523, collected by Griffith in Burma, but the leaves seem to be a different shape. A very distinct dainty species which should be collected again.

THE HERBARIUM,
ROYAL BOTANIC GARDENS,
KEW, RICHMOND,
SURREY, ENGLAND,
March 15, 1961.

N. L. BOR

Gleanings

Bernhard and Michael Grzimek: SERENGETI SHALL NOT DIE. Translated from the German by E. L. and D. Rewald. (Hamish Hamilton Ltd., London, 1960).

Rhinos sleep soundly and do not like to be disturbed. The Masai boys have devised a game based on this sound slumber. They steal up to a sleeping rhino and place a stone on its back. The next boy has to remove it without rousing the rhino. Then it is put back again and so on until the animal finally wakes up. This game is not without danger, of course, but it is typical of the Masai. (p. 50).

Contrary to general belief rhinos do not charge with the full weight of the one-and-a-half tons, but stop before they reach a car and prod at it with their 'horn'. Usually this only causes a dent in the coachwork. (p. 53).

Taxonomy: a neglected science. By John Hillaby, F.R.E.S., in the *New Scientist* (No. 220), 2 February 1961, p. 263.

When the recent expedition to South Chile, sponsored by the Royal Society, returned to Britain, some 20,000 entomological specimens from a relatively unknown part of the world were sent to the Natural History Museum for identification. It took one assistant nine months to set and mount the specimens which now occupy fifteen store boxes. It would have taken the Museum about 25 years to identify them completely, but as they are now being sent to specialists in many countries, the task will probably be accomplished in about ten years.

Notes and News

We are informed that the Indian Council for Agricultural Research is considering a scheme of research on the biology and life-history of bird and mammal pests of agricultural crops. The proposal contemplates the establishment of six regional centres, each studying one major and not more than three ancillary pests. The staff per centre will consist of one Agricultural Ornithologist, one Senior Assistant, and two Fieldmen. They will work under the Project Co-ordinator Dr. Sálim Ali, who will have his headquarters at Bombay, and be assisted by an Agricultural Ornithologist and a Senior Research Assistant. There will be a Research Fellowship of Rs. 150 for a B.Sc. or Rs. 200 for a M.Sc. attached to each centre. Ludhiana, Kanpur, Poona and Hyderabad have been suggested for four of the Research Centres. Among the pests proposed for study are Parrots (?), Flying Foxes, Crows, Weaver Birds, Sparrows, and Rosy Pastors. It is hoped that the Scheme will come into operation by April 1962. We welcome the news and hope that it will stimulate in the student community in India a greater interest in Field Ornithology than has been shown in the past.

* * * *

William E. Old Jr., Museum Specialist, The American Museum of Natural History, Central Park West at 79th Street, New York 24, N.Y., U.S.A., is interested in obtaining specimens of seashells from India. Persons and/or institutions likely to be of assistance to him are requested to communicate directly with him.

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Journal of the
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Vol. 58, No. 2

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Prater, S. H. (1948): The Book of Indian Animals, Bombay.

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8. Reference to literature in the text should be made by quoting the author's name and year of publication, thus: (Banerji, 1958).

9. *Synopsis:* Each scientific paper should be accompanied by a concise, clearly written synopsis, normally not exceeding 200 words.

10. *Reprints:* Authors are supplied 25 reprints of their articles free of charge. In the case of joint authorship, 50 copies will be given gratis to be distributed among the two or more authors. Orders for additional reprints should be in multiples of 25 and should be received within two weeks after the author is informed of the acceptance of the manuscript. They will be charged for at cost plus postage and packing.

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The White Rhino of Hluhluwe

BY

O. H. DE ST. CROIX

(*With two plates*)

Mention of a game reserve in the Union (now Republic) of South Africa usually turns the mind to the world-famous Kruger National Park in eastern Transvaal, with its vast area and great range of wild life. It may not be generally known that there are a number of much smaller game reserves in different parts of the Union, some of them for the protection of a particular species in its former habitat. The province of Natal has been especially forward in establishing smaller game reserves of this kind, most of which are in the Zululand area. Among these are the two White Rhinoceros reserves at Hluhluwe and Umfolosi, of which the former appears at present to be much the better organised for casual visitors.

The Zulu language, though melodious to the ear, presents some formidable problems to the foreign tongue, with its register of clicks and other pitfalls of pronunciation. At first sight the word Hluhluwe seems to be one of them. But if the two 'hl' sounds are pronounced as rough aspirates and the ending is made to rhyme with 'Hooey' the result will be understandable to the local inhabitants.

This Reserve (estimated at 57,000 acres or 89 sq. miles) lies in the northern part of Zululand about 180 miles north of Durban and is easily accessible by motor road. For a start the way lies along the new Natal north coast national road and one might be travelling through the south of India so thick is the Tamil population of the towns and villages along the first 30 miles or so of the route. Then, after passing the modern town of Stanger, once the site of Shaka

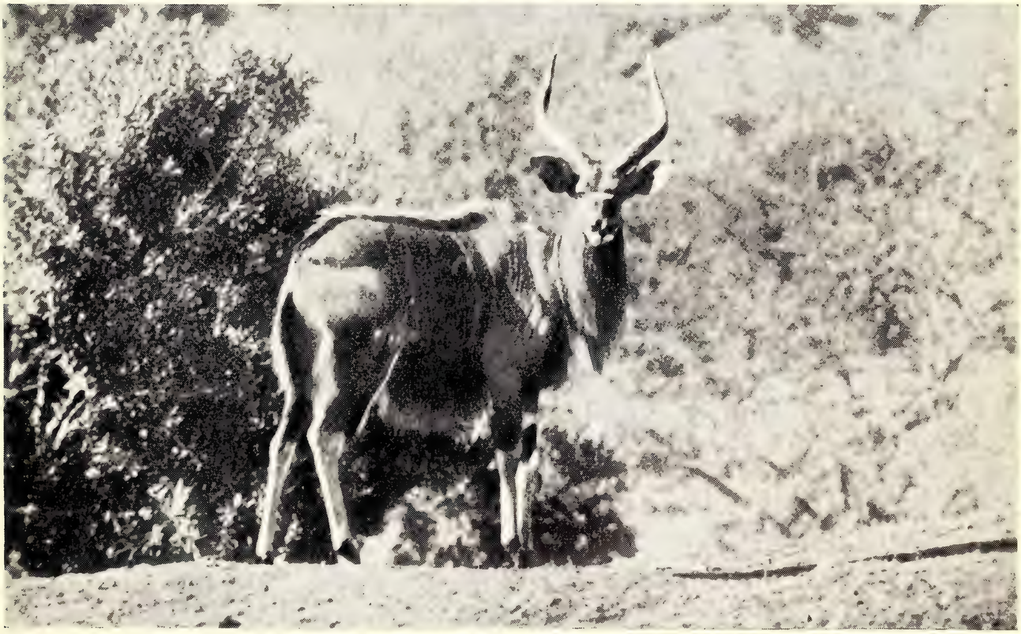
Zulu's royal kraal a fine new bridge carries the road over the historic Tugela River into what is now the heart of Zululand. There is ample evidence hereabouts that sugar is king, for on either side of the road as far as the eye can see stretches an apparently limitless sea of sugar cane. It is not grown here in small patches as in India but in mass, sometimes extending unbroken over many acres. The result is that the pastoral scenery typical of Zululand, with its gently undulating down-like hills and occasional patches of bushveld, has been transformed.

On reaching Mtubatuba some 150 miles from Durban there are signs that the modern way of life is being left behind. From here the road stretches away, metalled but not asphalted, to Swaziland and the Mozambique border. The way to the Reserve shortly takes a turning off inland and almost at once one is in a much wilder environment. It is now a landscape of steeper undulations, extensive stretches of bushveld, and occasional rocky outcrops. It is not a thickly populated region and only small bee-hive kraals are to be seen dotted about sparsely. There are not many signs of cultivation but cattle of many sorts abound and there is every appearance of overgrazing.

Soon another turning branches off and thence the way is over little more than a rough track. In a few miles this reaches the fenced and gated boundary of the Reserve. Here visitors have to check in with their reservations at the gate lodge and are also given comprehensive information and instructions covering their stay. The road then runs for several miles through the Reserve itself. At first it is past open savannah and park-like country. Presently thick bush closes in on both sides and, although a fair speed is being kept up, quite a variety of wild life is to be seen in fleeting glimpses. A troupe of baboons, a party of guinea fowl, several wart hog and Impala antelope, a solitary Nyala buck are all visible by the roadside and scarcely heeding. Then of a sudden the road starts twisting and climbing through picturesque scenery up to the ultimate destination.

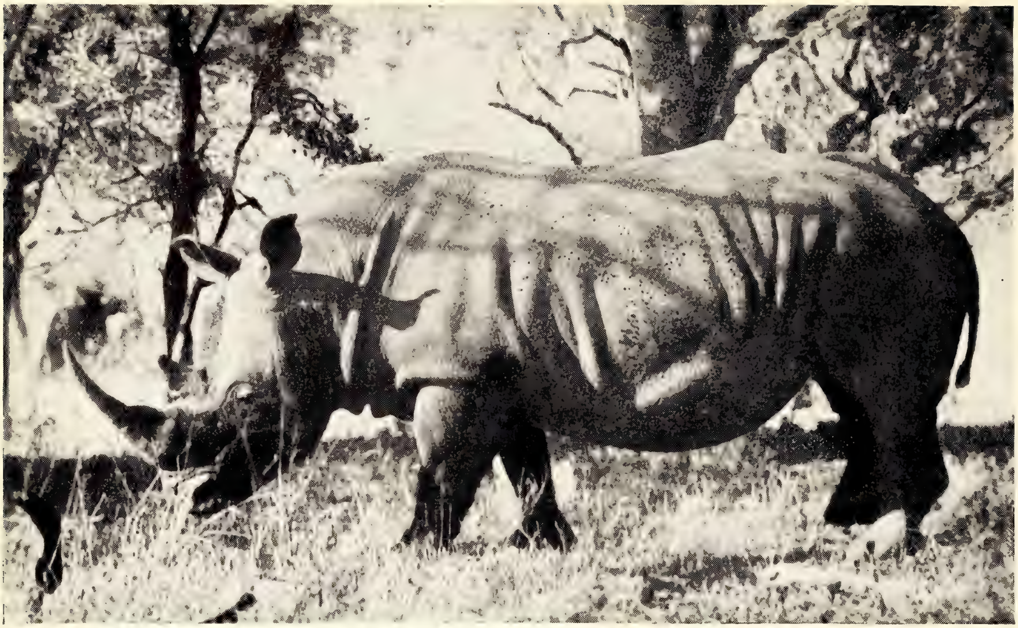
The camp site is ideally located along the flat top of a narrow ridge at an altitude of about 1500 feet (460 m.) above sea-level. Coolness is thus assured at all times of the year and an absence of insect pests. There are delightful views on either side over grass-covered hills and deep wooded valleys. Thick forest lines the valley floors wherever perennial watercourses run and, where the hillsides have been sharply weather-carved, rocky cliffs and peaks protrude to vary the scene. Sometimes through binoculars wild life can be watched without even moving from the camp itself.

Visitors' Rest Camp at Hluhluwe Reserve

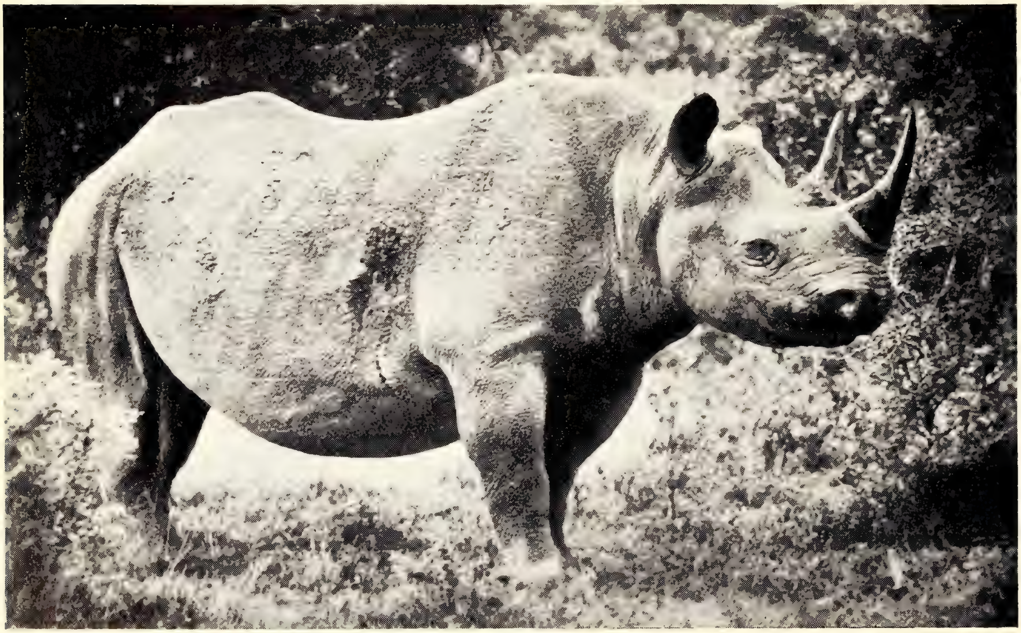


Nyala Buck in Hluhluwe Reserve

Courtesy : Natal Parks, Game & Fish Preservation Board



Square-lipped ('White') Rhinoceros



The Common, or Black Rhinoceros in Hluhluwe Reserve

Courtesy : Natal Parks, Game & Fish Preservation Board

Accommodation in the camp is of two kinds. There are cottages (not shown in the illustration) each absolutely self-contained and designed to house under one roof a party of up to six people if necessary, but four more comfortably. The suite consists of 2 large bedrooms, a sitting room, a dining room, a bath-room and a fully-equipped kitchen with store-room. The rondāvels (which are as shown in the illustration) are bed-sitting rooms for two with washing and eating facilities centralised externally. In either case the accommodation is fully and comfortably equipped and spotlessly clean. Literally, all the visitor has to bring are his food and drinks, except drinking water. All one has to do on arrival is to hand over one's supplies to the well-trained Zulu staff and the rest, with very little supervision, can be left to them. The camp has its own electric supply with current cut off between the hours of 10 p.m. and 5 a.m., running hot and cold water, with flush sanitation, and a limited petrol supply; telephone and telegraph facilities are also available. For all this the inclusive cost of occupation (excluding food and drink) should average between 15 shillings and 25 shillings per head per day only, according to the type of accommodation used.

Other items of administrative interest are: no dogs are allowed, bookings may not be made for more than 5 nights or more than 3 months in advance, there is a vehicular speed limit throughout of 25 miles (40 km.) per hour, and visitors are strictly confined to camp between sunset and sunrise, no one may camp out or sleep in a vehicle within the Reserve, no one may tour the Reserve without an authorised Game Guard or get out of a car while touring unless accompanied by him. It does not need much imagination to appreciate that these regulations are framed for very good reasons in the best interests of the visitors themselves.

Our arrival coincided conveniently with tea-time and, once the essentials of registering at the camp office, unloading gear, and onloading some tea are complete, we are ready to make the most of an evening excursion. A Zulu guide is allotted to us without delay, a strapping young man in smart khaki uniform and obviously capable of dealing effectively with even the most tiresome visitor. His knowledge of English is limited but one of the party is fortunately fluent (though clickless) in the Zulu language which adds very greatly to the interest of everything. These Zulu guides are also guards vested with certain powers, the tangible evidence of which is a pair of handcuffs fixed to their belts. They seem to be men carefully picked, not only for their physique and intelligence, but also for their knowledge of and interest in wild life. They are certainly an impressive body of men who would be a credit to any organisation.

So, fully imbued with confidence in our guide now installed in the car, we set off not long after arrival down-hill in the opposite direction to that from which we came. It is the dry season and dusty, but the grass is short, visibility good, and the animals concentrated where there is good grazing. Almost at once we are in sight of Wildebeest (Gnu), Zebra, and Impala, the last named in some numbers. Presently, as the road descends into thicker bush, we begin to see Nyala in ones and twos but quite frequently. This is a species which is not so well known as most, being shy and a lover of dense cover. But it is quite a speciality in this Reserve, where it can be seen at very close quarters and to good advantage. It is not very spectacular as antelope go, yet the illustration will show that it has a distinctive beauty, a good deal of which is unfortunately lost without the colouring. The adult buck is a deep chocolate-brown with irregular, cream-coloured, vertical stripes, and quite modest horns with a single backward-sweeping twist. The doe and the young are a vivid chestnut and always seem to be in the sleekest of condition.

The next animal to come on view is a patriarch among male baboons sitting with a bored, proprietary air on a rocky eminence quite close to the road. But he is allowing no familiarities, for as soon as the car stops he turns his back rudely and ambles away. He utters a grunting signal call to his troupe as he goes and the swaying of trees all over the hillside shows that they are taking rapid but unseen evasive action. A little further on the guide suddenly jerks to the alert and says the word for which we have all been waiting—'Rhino'. But even with 2 pairs of binoculars trained on where he is pointing there appears to be nothing but the usual termite heaps and rocks protruding from the bushveld. Then one of them shifts and turns and the identification is obvious. It is a tribute to the guide's keenness of sight that he could pick out an object like this from a moving car about a quarter of a mile away. A quick appraisal of the situation now shows that we are up-wind, too far away and also that the light is wrong for photographs. So the car is turned and a long detour made to another road, which brings us down-wind and much closer to the objective.

We are now about 150 yards (140 m.) only from the nearest rhino and are able to see with some disappointment that it is one of the nearly related and much commoner 'Black' species. But the disappointment is partly offset by the prospect of possible excitement.

For the guide at once makes it clear that no liberties whatever are to be taken. We are allowed to get out of the car but only to move a few paces from it. The doors are all left wide open and the engine running, so that a very quick get-away can be made if necessary. As soon as the binoculars are focussed the reason for these precautions as also for most of the rules governing all conduct in the Reserve become obvious. The 'Black' Rhino is a most vicious and aggressive-looking animal. Though very heavily built his quarters give an impression of ponderous agility concealing a deceptive speed of movement, like an outsize all-in wrestler and just as ugly. His head is held high, tapered and fully armoured, the business-end of a powerful, self-activated battering ram. This one, the bull of the party, is evidently feeling his responsibilities and prepared to take on anything. He has detected the presence of humans but is unable to locate them precisely, which is exactly what our guide had planned. He shifts about, testing the air and snorting unpleasantly. We watch him closely through binoculars while photographs are taken, to the reassuring accompaniment of the car engine' ticking over healthily. He is joined by a female of the species which appears to have a soothing effect; a third animal remains rummaging in the bush. But this interesting encounter has to be cut short since the position of the sun indicates a move homeward, somewhat to the guide's relief. He is under no delusion as to the Black Rhino's real character. The way back to camp is now by a wide circuit, touching the boundary of the Reserve, which has to be covered at fair speed. Yet there is something of wild life to see almost continuously. Unfortunately birds are not very plentiful in such dry weather. Guinea fowl are the most conspicuous and there are several glimpses of a small bustard, whose shyness makes exact identification impossible. A stop cannot be resisted when a herd of Buffalo is sighted, though some way off, grazing slowly along a steep, grassy slope. Except for the adult bulls they are not nearly such impressive animals as their Indian counterparts. Time has by now almost run out and the study of them has to be abandoned. As it is, the camp gate is reached only just before sunset.

When leaving us for the night our guide made it firmly but politely clear that a very early start was called for the following morning. So the whole party is up with the sun and witnesses a smart parade of the entire staff of Camp Guides. As soon as they are dismissed we are rejoined by our man and are soon on our way to a part of the Reserve not yet visited. At this early hour wild life is afoot in abundance. At first it is wart hog which steal the show, since they are the quite unwitting comedians of the bushveld. Almost invariably they greet the visitor with a prolonged and searching stare. With snout held high and the formidable array of tusk well to the fore, there is a distinct resemblance to a senior army officer flaunting his traditional bristling, white moustache in highly truculent mood. The scrutiny complete, there is an abrupt about turn and the hog makes off at a smart trot, his whip-like tufted tail held rigidly vertical as an eloquent sign of extreme disapproval. His plump little hindquarters seem to work overtime in keeping up with his more shapely forelegs and look like those of a squat scrum-half whose shorts are too tight for him.

Impala are on view in large numbers all along the road. A small herd composed entirely of bucks all with fully-developed horns shows what beautifully graceful creatures these antelopes in the adult male stage really can be. Elsewhere some does with fawns give an exhibition, for no apparent reason, of their well-known running-jumping act. In succession they literally soar through the air with a series of immense, leaping bounds as though impelled by hidden springs in their feet. If there were to be an animal Olympiad an Impala would surely be the hop-step-and-jump gold medallist. Further on a large herd of Wildebeest puts on for our benefit a sort of mass manoeuvre like a squadron of riderless cavalry on parade. They wheel and counter-march raggedly and then finish facing the car in a bunched, irregular line-abreast pawing the ground and snorting as though expecting applause.

Two new species now appear. A family of Waterbuck are seen standing close together in the open, frozen to inconspicuousness. Stocky and well built with heavy neutral-coloured coats, the buck has thick, corrugated, lyre-shaped horns and they all give an impression of extreme physical fitness and a capacity for endurance. Then there is a passing glimpse of two doe Kudu, rather unshapely and inelegant, with dowdy colouring and nervous, spinsterly temperament. They lack distinction but raise our hopes high of seeing a buck of the species, which certainly must share with the Sable (apparently not represented in this Reserve) a claim to being the most imposing and handsome of all the antelopes.

At a point where the road runs along the crest of a bare ridge commanding a good view the car is stopped, and the whole party deploys to bring binoculars into play. A long way off there is a herd of buffalo, aloof and grazing busily. But they are too far away to be watched with any interest. Somewhat nearer, on a steep open hillside is a large object like an animated, earth-coloured tank-lorry, shambling around evidently in urgent search of fodder which is not so plentiful in this very dry season. The guide confirms that it is a 'White' Rhino but it is too far off to approach closer on foot and judging by its restless movements it has no intention of staying put for very long. So we have to be content with this very distant view until in a few minutes the Rhino disappears in its strenuous search for an adequate meal to start the day.

We now turn homewards on a circuitous route but there is still one more interesting encounter to come. From the top of a tallish thorn tree protrudes a row of shapely heads and at first sight it looks as though some of the larger antelope population have been indulging in climbing exercises. But closer inspection reveals that we have met the Reserve's one family of Giraffes. We advance to meet them on foot and, since they do not move, stand staring at them at a few yards' range with the thorn tree in between. The Giraffes, a female with partly grown young, remain motionless and return the stare with gentle, melting eyes, looking down on us with a pitying expression on their faces. Soon tiring of this mutual admiration society, we retrace our steps leaving the Giraffes still in the same position as when we first saw them. On the way we meet the bull of the herd, a huge handsomely-marked animal, by now quite a well-known character in this Reserve. He appears overjoyed at seeing us and follows like a dog back to the car. Even when we get in and slam the doors he still stands close by as if expecting something. He is now so close as to be within touching distance and we see every detail of his markings, including large numbers of ticks clustered on his underside. But the limit is reached when, overcome by curiosity or impatience, he tries to push his enormous head in at one of the windows. We start off abruptly back to the camp for, however friendly his intentions, a Giraffe of this size might be quite capable of overturning the car.

Since we have still not had a proper view of the real object of our visit, our guide insists that there will be no siesta. As this is our last afternoon we are obliged to admit the force of his contention. So at about 2 p.m. we set off again. It is the hottest time of a not very hot day and, unlike us, most of the animals are by now enjoying their siesta. But whereas the majority of them find full concealment in so doing, the 'White' Rhino, as our guide well knows, has long since given up trying to hide his enormous bulk merely for the observance of a daily routine. Thus for one who knows where to look it must be the easiest time of day to locate this animal and by the way our guide is looking out of the window he is obviously confident of success. Sure enough before long he makes an urgent signal to stop and leaps out while the car is still moving. We look in the direction he is pointing and there, about half a mile (800 m.) away under an acacia tree, lies a mountainous grey shape, so large as to make the tree look like a lady's parasol. Binoculars identify it at once as an enormous 'White' Rhino, lying fast asleep with his legs tucked under him and his snout resting on the ground as if tired of supporting the large, scimitar-like nose-horn. The guide explains that we are now to make a tactical approach on foot to within range for close-up photography, and off we go at a cracking pace. A Zulu's idea of a cross-country walk is austere to say the least. It takes no account of thorn bushes, rocks, dry water-courses, steep banks, and the like; nor does it make any allowance for the softness engendered by 'civilised' life. We follow as best we can and are soon past caring. Then of a sudden, before we are fully prepared for it, we find ourselves with nothing but about 40 yards of bare veld between us and the still slumbering Rhino. The guide obviously scornful of our sweating and breathless condition, whispers that the time for photography will be strictly limited. We try to steady ourselves by looking through binoculars and are fascinated by what we see at such close quarters. But the Rhino is not alone, for clambering about his body are two ox-peckers, drab-coloured birds of the starling family, with blood-red beaks and about the size of a myna. Their function is to relieve their host of ticks and other parasites and this they are now doing with tireless energy, not omitting the most intimate and impertinent inspections. By way of reciprocation they appoint themselves as watchmen and presently these two give the alarm. The Rhino springs to its feet with surprising agility and at once stands facing us, apparently having been warned of our exact position.

The first impression is of a creature of gigantic size, like a sizeable elephant on short legs. It is now evident that this is a fully adult male and one is told that these stand nearly 6 feet at the shoulder and can weigh up to 5 tons. Yet its whole bearing and attitude reflect a humble docility which dispels any feeling of fear at the proximity of so huge a wild animal.

It may here be explained that the designation 'White' as applied to this species is really a misnomer and that it should more properly be called the 'Square-lipped' Rhino from a physical attribute which the illustration does not show clearly (the illustration incidentally is of a much smaller specimen than that described). For whereas the other species is a browser and, as we saw yesterday, stands with his head held aggressively high, the Square-lipped Rhino is so equipped for grazing, and stands ponderously with its head held low like a corpulent old man bowed at the shoulders.

There is something enthralling about standing within a stone's throw of one of the world's rarest and largest land animals. It does not take long to realise why this one so nearly suffered extinction. For despite its great size and potential strength it is ill-fitted either physically or by temperament to protect itself against man's incessant persecution. Its equipment requires a sheltered, inoffensive life in an environment governed solely by Nature's own checks and balances.

The Rhino returns our inquisitive stare with timid, puzzled eyes and turns from side to side as if uncertain what to do next. A cloud of flies and other insects rises from its body at each movement and hangs around it like a haze. Then, satisfied as to our harmlessness and evidently convinced that it is not worth while resuming the interrupted siesta, it ambles slowly away on an erratic course across the veld grazing at random as it goes. We watch it out of sight with mixed feelings, composed of sympathy for such a mountain of helplessness and of satisfaction that something substantial has been saved from the welter of 20th century destruction.

As a finale we are taken to a place where the track ends on the bare summit of a hill, whence a fine view is to be had. From here there is a panorama covering a large area of the Reserve and comprising almost every type of scenery to be found in the South African bushveld. With a few sweeps of the binoculars our now practised eyes can pick out most of the species which have been encountered at closer quarters. Zebra are present in numbers but it is surprising how such a dazzle-coated creature can make itself so inconspicuous in broad daylight merely by standing still in the shadow of a tree. On a grassy slope below us stands a solitary Secretary Bird, easily identified by his slate-grey plumage and lanky build, a characteristic but increasingly rare sight in this type of country. He is an eagle on stilts, the arrangement of whose head feathers gives him his name and makes him look like a lean and spindly individual who has not brushed his hair. As we watch he struts about with a rolling, nautical gait searching the ground for food in a most un-eagle-like way. In some scrub jungle just beyond a rhino is moving around, but it is impossible to determine the species with only a rear view of its broad back. Overhead a pair of Bateleur Eagles soar and wheel in widening circles. While so doing they display their curious propensity for side-slipping instability in flight as though indulging in a form of controlled aerobatics. Can this be due to their having been equipped by nature with most unusually short tails?

Then an excited comment from one of the party draws all binoculars to the point on which he is focussed. The glint of sun on a moving horn betrays the presence of a large animal. Can it be the one species we have so far missed seeing? A pair of binoculars is handed to the guide and without hesitation he confirms that it is what we hoped for. At last we have located a Kudu buck and a very fine one too. At first he is half concealed by the bush on which he is browsing. But soon, as if to oblige, he steps out into the open and stands in the full afternoon sunlight, showing to perfection what a superbly magnificent creature a male Kudu is in its prime. He is as large as a medium-sized pony and beautifully proportioned, with long, massive spiral horns flowing straight up from his head in perfect symmetry. The guide says there is a second buck present, having somehow spotted it with his naked eye. He points disdainfully to help out our fumbling efforts with the binoculars; at last we pick him out standing still in shadow, a marvel of protective coloration. He is every bit as fine a specimen as his companion, and it seems absurd that we could so easily have missed such a large animal in the open. But even in daylight the mouse-dun coat broken up with pale, irregular, vertical stripes provides a perfect camouflage when motionless. Now for several minutes we are able to enjoy an uninterrupted view, in a setting that could hardly be bettered, of a species which is certainly one of Nature's masterpieces. Then of a sudden they both appear to sense that they are under human observation and fade quietly into the bush.

We return to our base for the last time, reluctantly but with a feeling of deep satisfaction at having seen all we set out to see under such delightful conditions. There is a distinct atmosphere of depression the next morning at having to go back so soon to the 'civilised' way of life.

What lessons does the example of the Hluhluwe Reserve hold for the Indian conservationist? Local conditions and the type of wild life to be preserved do, of course, differ widely. But certain broad conclusions can undoubtedly be drawn.

Here in the first place is evidence that to be successful a Reserve need not necessarily be of enormous size, even if located in a settled agricultural region. For given good grazing with adequate perennial water supply, both properly husbanded and conserved, and provided species suitable for the environment are selected for preservation, it is evidently possible to contain a large stock within a limited area without undue straying. In this context Hluhluwe maintains a very considerable stock of grazing and browsing animals without, so one is told, any predators. It would clearly be inadvisable to introduce lions in so restricted an area, but there appears no reason why leopard or cheetah could not be allowed. In the circumstances one wonders how the necessary checks are provided so as to prevent the usual consequences of overpopulation, which in the case of some species already appears to be in sight. Possibly judicious control is exercised by the wardens themselves or some of the lesser predators may in fact be present unseen in small numbers. It is an interesting question on which the writer unfortunately was unable to obtain any authoritative information.

Then again conditions at Hluhluwe give a satisfactory answer to the charge commonly made, and unhappily too often substantiated, that a game reserve merely creates a poacher's paradise. This will only be so if there is an inadequate staff or a staff insufficiently trained and of the wrong calibre or not vested with powers appropriate to the efficient discharge of their duties. The confiding behaviour of most of the animals in this Reserve bears eloquent enough witness to the very thorough control over human molestation which the staff is able to maintain.

Finally, and by no means least important, there is the practical demonstration that a well-stocked and intelligently-administered game reserve, backed by a soundly organised and comfortably (but not luxuriously) equipped rest camp can be an attraction to visitors from overseas in large numbers. 20,000 people visited the park in 1960, and it can hardly be denied that this represents a significant national asset.

Critical Notes on the Orchidaceae of Bombay State

VI. *NERVILIA* GAUD. & *MALAXIS* SW.

BY

H. SANTAPAU, S.J., F.N.I. AND Z. KAPADIA, PH.D.

(*With three plates*)

[*Continued from Vol.* **58** (1) : 67]

NERVILIA Comm. ex Gaud.

NERVILIA Comm. ex Gaud. Bot. Voy. Freycinet 421, 1826, nom. cons. ; Pfitz. in Engl. & Prantl, Pflanzenf. 2 (6) : 106, 1888 ; Schltr. Orchid. 101, 1927 ; Sprague & Fischer in Kew Bull. 1927 : 363 ; Holttum, Rev. Fl. Malaya 1 : 104, 1953. *Pogonia* Endl. Gen. Pl. 218, 1837, p. p. ; King & Pantl. in Ann. R. Bot. Gard. Calcutta 8 : 265, 1898, p.p. ; J. J. Smith, Fl. Buitenz. 6 : 53, 1905 ; Duthie in Ann. R. Bot. Gard. Calcutta 9 (2) : 157, 1906 (non Juss. 1769). *Pogonia* sect. *Nervilia* Benth. & Hook. f. Gen. Pl. 3 : 615, 1883 ; Hook. f. Fl. Br. India 6 : 118, 1890.

The name *Nervilia* is derived from the prominent veins in the leaves of several species.

Perennial, tuberous *herbs*, mostly coming into leaf after flowering. *Tubers* globose, usually with small warty root-knobs, generally dirty-white in colour. *Leaf* one, petiolate, broadly cordate or orbicular, plicate, glabrous or variously pubescent. *Inflorescence* erect, bearing 1, 2 or several flowers in racemes. *Flowers* erect, horizontal, nodding or drooping. *Sepals* and *petals* subequal, spreading, rather long and narrow. *Lip* inferior, adnate to the base of the column, sessile or sub-clawed, entire, or 3-lobed, often slightly saccate at the base, embracing the column in the basal region. *Column* elongate, straight or slightly curved, footless, broadening upwards to contain the stigmatic surface and the anther. *Anther* sub-stipitate, almost horizontal ; pollinia 2 bifid, or 4, granular, yellow, without caudicles or glands. *Stigmatic surface* oblong, or somewhat quadrate, broad.

Species about 40 to 50, distributed from Africa to India and China, and through Malaysia to Australia.

The Bombay species have been put under *Pogonia* Juss. by Cooke (in FL. PRES. BOMB. 2 : 706, 1907) ; in this he follows Hooker f. and Bentham & Hooker f.'s treatment of this genus, though the latter authors distinguish *Nervilia* Gaud. as a section of *Pogonia* Juss. We consider *Nervilia* Gaud. a distinct genus, differing primarily from *Pogonia* Juss. by the production of their flowers before the leaves, and by having a separate stem which bears no leaves but may have scales or scaly sheaths.

The generic name *Aplostellis* attributed in *Ind. Kew.* to Thouars, *Orch. Iles Austr. Afr.* t. 24, 1822, has been adopted by Ridley (FL. MALAY PENINS. 4 : 203, 1924) in place of *Nervilia* Gaud. (1826) on the ground of priority of publication. Sprague and Fischer have shown that *Aplostellis* Thouars is ' . . . not a generic name but the name of a species. A critical examination of Thouars's preliminary paper "Sur l'histoire des plantes orchidées des îles australes d'Afrique" (Nouv. Bull. Soc. Philom. Paris 1 : 314-319, 1809) and of his "Orch. Iles Austr. Afr." (1822) shows that he attempted to introduce two innovations into the nomenclature of Mascarene Orchids : (1) that all generic names of *Orchidaceae* should end in *orkis* (orchis) ; and (2) that each Mascarene species of that family should be known by a single name instead of a binary combination. These innovations were not accepted by other botanists and when Thouars published his plates of *Mascarene Orchidaceae* in 1822 he employed a double system of nomenclature in the tables and plates, the names of these genera and species according to his own peculiar method being followed by corresponding names in accordance with the established system. Thus *Aplostellis* Thou. was the uninomial name of a new species from Mauritius, which he placed under the new genus *Stellorkis* (*Stellorchis*) ; he appended the new binary combination *Arethusa simplex* for those who preferred to follow the generally accepted methods of nomenclature. The mode of formation of the uninomial names of the species was explained in Thouars's preliminary paper. The first half was an abbreviation or Greek translation of the trivial name ; and the second half was composed of the first part of the generic name with the suffix *-is*. Thus *Aplostellis* is a portmanteau word composed of *Aplo-*, the Greek equivalent of *simplex*, and *stellis* a contraction of *Stellorkis*.

' *Aplostellis* as a generic name was proposed by A. Richard in 1828, but this is antedated by *Stellorkis* Thou. (1809) and *Nervilia* Comm. ex Gaud. (1826) '. The name *Nervilia* Comm. ex Gaud. has been conserved for the genus.

The following is the synonymy of *Nervilia* (*Aplostellis*) as given by Sprague and Fischer (loc. cit.) :

Nervilia Commerson ex Gaud. in Bot. Voy. Freycinet 421, t. 35, 1826, *nomen conservandum*. *Stellorkis* Thou. in Nouv. Bull. Soc.

Philom. Paris 1 : 317, 1809. *Stellorchis* Thou. Orch. Iles Austr. Afr., Tabl. Genres, 8, t. 24, 1822. *Cordyla* Blume, Bijdr. 416, 1825 (non Lour. 1790). *Aplostellis* A. Rich. in Mem. Soc. Hist. Nat. Par. 4 : 36, 1828. *Roprostemon* Blume, Fl. Jav. vi, 1828, sub nomine *Cordyla. Haplostellis* Endl. Gen. Pl. 219, n. 1603, 1837. *Rephostemon* Endl. loc. cit. 216, n. 1578, 1837. *Haplostellis* Reichb. Nomencl. 1 : 56, 1841.

Most species of *Nervilia* are found in a definite ecological habitat. In open fields they are often found under the shade of hedges of cultivated fields. Very often one or more rows of the orchid in leaf or in flower may run parallel to the hedge. In forests these species are found growing in spots with plenty of rotting leaves. The tuber produces an inflorescence ; one leaf per plant appears after the wilting of flowers ; each plant gives usually 2 slender horizontal, underground stolons, which produce new tubers at their end. The latter at first produce leaves, but in subsequent years flowers are first produced, then leaves. Thus vegetative propagation is quite prolific in this genus. We have observed that flowering in *Nervilia* strictly coincides with the very first showers of the monsoon ; in N. Kanara, where the monsoon sets in early, often by the last week of May, flowering is practically over by the first week of June ; in Salsette Island the monsoon generally does not begin till about the middle of June, and the flowers of these plants usually come about the third week of June.

Type species : *N. aragoana* Gaud.

KEY TO THE SPECIES OF *NERVILIA* OF BOMBAY

BASED ON LEAF CHARACTERS

1. Petioles 2-5 cm. long ; leaf-blade lying more or less flat on the ground :
    2. Leaf-blade glabrous, green with 5-7 broad chocolate-coloured bands along the nerves .. .. *infundibulifolia*
    2. Leaf-blade pubescent, green or purple :
        3. Leaf-blade pure green, with pale green or somewhat white hairs :
            4. Leaf-blade 2-12 cm. in diam., orbicular-cordate, subreniform, subplicate, hairy on the upper surface, glabrous or glabrescent below .. *monantha*
            4. Leaf-blade 4-16 cm. in diam., ovate-cordate, acute or subacute, plicate, hairy on both surfaces .. .. *discolor*

3. Leaf-blade deep purple or green-purple to rusty-brown with stiff pale or deep purple hairs in regular rows on both the surfaces .. .. *discolor*

1. Petioles 8-20 cm. long ; leaf-blade not lying flat on the ground .. .. *juliana*
aragoana
carinata

BASED ON FLOWERS

1. Scape 1-flowered :

2. Sepals and petals 13-15 mm. long ; lip 3-lobed; midlobe glabrous, entire, obovate or obovate-oblong, rounded, midnerve prominent and callus-like *infundibulifolia*

2. Sepals and petals 17-25 mm. long ; lip scarcely lobed ; midlobe or its apical portion much wrinkled, subfimbriate, somewhat 3-4-lobulate, hairy on the nerves .. .. *monantha*

2. Sepals and petals 25-35 mm. long ; lip 3-lobed ; midlobe rhomboid or rhomboid-ovate to rhomboid-lanceolate, acute or subacuminate, hairy within .. .. *juliana*

1. Scape 2-flowered ; flowers at right angles to the scape ; lip scarcely lobed, the apex somewhat retuse .. .. *discolor*

1. Scape several- to many-flowered ; flowers drooping ; lip 3-lobed :

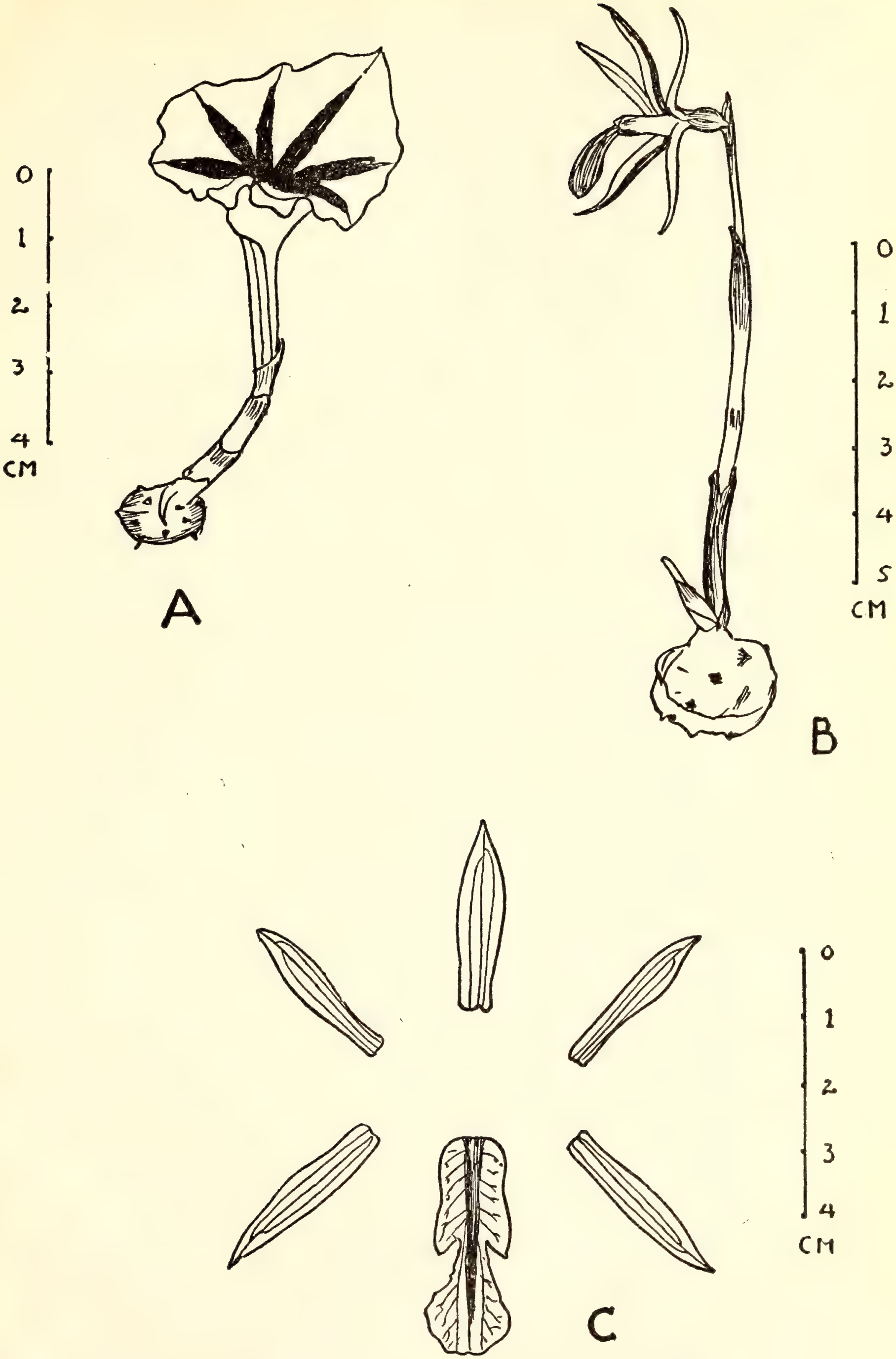
2. Floral bracts deflexed ; lip slightly saccate at the base ; midlobe not constricted at the base, ovate or ovate-oblong, rarely suborbicular, rounded with incurved, erect edges ; column rounded on the dorsal side, flat in front .. .. *aragoana*

2. Floral bracts erect ; lip not saccate at the base ; midlobe somewhat constricted at the base, straight, ovate or rhomboid-ovate, tapered to an acute or subacuminate apex ; column with a strong keel on the dorsal side, making it 3-angled .. .. *carinata*

ENUMERATION OF THE SPECIES OF *NERVILIA* OF BOMBAY STATE

1. **Nervilia infundibulifolia** Blatt. & McC. in Journ. Bombay nat. Hist. Soc. 35 : 725, t. 3, 1932 ; Santapau in Rec. Bot. Surv. Ind. 16 (1) : 304, 1953. *N. hallbergii* Blatt. & McC. ibid. 726, 1932 ; Santapau 304. (See Plate XXXI).

Tubers 6-12 mm. in diam., subspherical, slightly flattened above and below, sparsely covered with small root-knobs. *Leaf* flat on the ground or slightly above the surface ; sheaths about 1-2 cm. long, light brown, translucent, oblong, acute to subacuminate, entire, purple-nerved ; petioles 2-4 cm. long, dark-brown purple above, turning lighter below, terete, grooved, ridged, opening into a slightly enlarged funnel-shaped mouth at the base of the lamina ; lamina 2-3 × 3-4 cm. glabrous, broadly ovate, cordate to suborbicular, subacute, obtuse or slightly retuse at the apex ; margins brown-maroon, crimped, irregularly and minutely dentate-crenulate ; nerves 5-7, rarely 9 pairs, the last pair generally thin ; upper surface dark grass-green with broad chocolate-coloured bands along the nerves, broadening in the middle but not reaching the margin ; lower surface light green with prominent dark-brown nerves, corresponding to the depressed ones above. *Inflorescence* one-flowered ; scape 6-15 cm. (often reaching 27 cm. in fruit) tall, terete, pale maroon, of 2 internodes ; sheaths linear-oblong, obtuse, entire, 5-nerved ; the upper sheath about 3-3.5 cm. long, wide-mouthed, the lower much shorter, closely appressed. *Flower* at about right angles to the scape or nodding, greenish purple. *Bract* 3-7 × 2-3 mm., subconcave, ovate, or ovate-oblong, acute, entire, 3-nerved, maroon, the nerves deeper in colour. *Pedicel* 1-1.5 mm. long, curved, pale purple. *Sepals* and *petals* similar, slightly concave, light maroon-green with maroon veins, linear-lanceolate, broader in the middle, acute, entire, glabrous. *Sepals* 13-15 × 3-4 mm., 3-nerved. *Petals* 12-14 × 2-2.5 mm., sparsely or not at all gland-dotted, 3-nerved, the midnerve more prominent. *Lip* 16-17 × 5-6 mm., saccate at the base, gland-dotted, 3-lobed ; lateral lobes 8 × 2 mm., pale apple green, acute or subobtuse, entire, more or less embracing the column to form a tube, the latter about 3 mm. broad at the mouth, narrower behind ; midlobe 9-10 × 6-7 mm., broadly obovate to even suborbicular, rounded (rarely subretuse) at the apex, the margin somewhat wavy, deflexed on the sides, minutely denticulate ; the midlobe white or pink suffused irregularly all over with more or less deep patches of rose-maroon, the midnerve callus-like, white. *Column* 8 mm. long, 2 mm. broad at the top, 1 mm. below, straight, flat in front, rounded behind, pale apple green with at times faint red-maroon narrow longitudinal streaks. *Anther* 3 × 2 mm. white or faintly tinged with purple-maroon in front ; pollinia 2, in the shape of a broad exclamation mark. *Stigmatic surface* large, longer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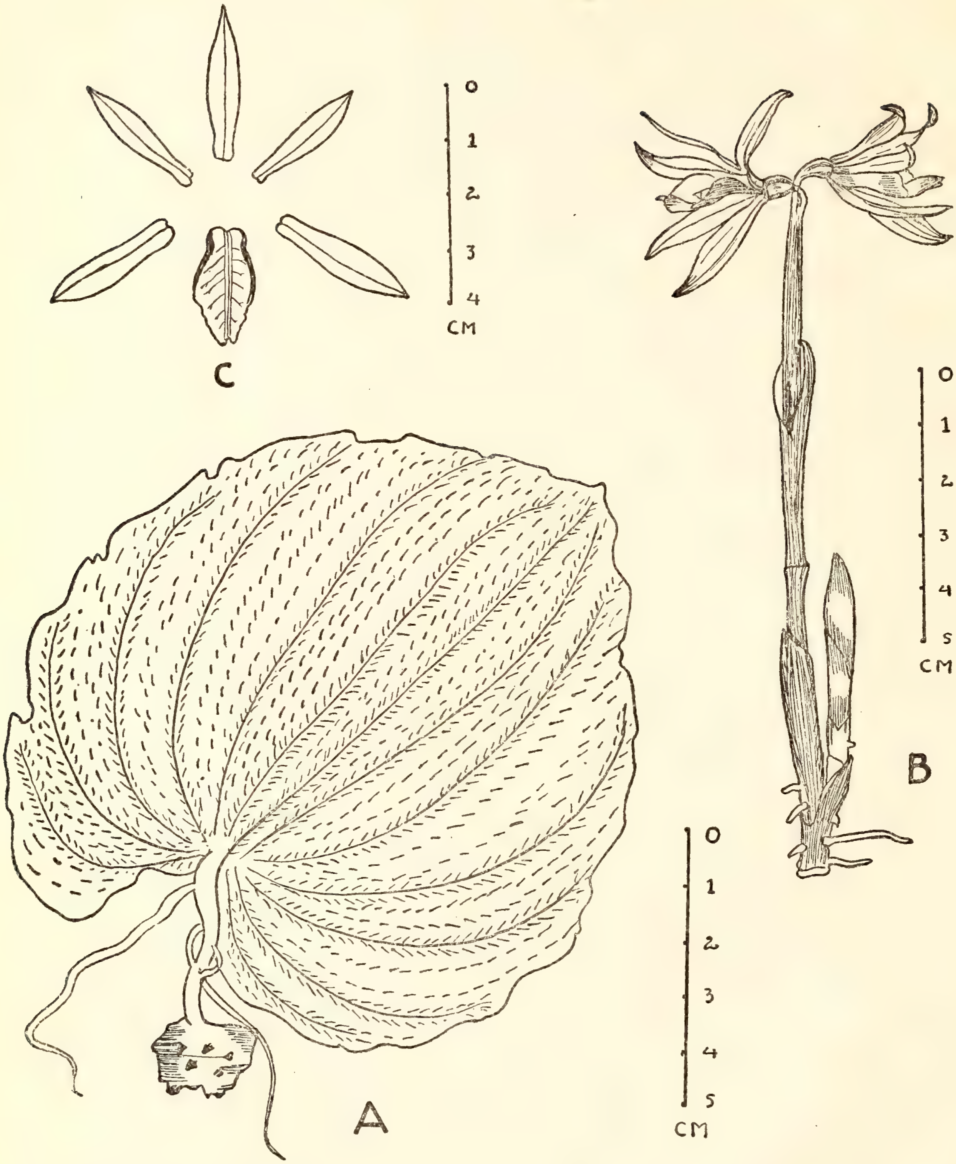
Nervilia infundibulifolia Blatt. & McC.

A. Plant in leaf; B. Plant in flower; C. Sepals and petals dissected.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Nervilia discolor Schltr.

A. Plant in leaf; B. Plant in flower; C. Sepals and petals dissected.

than broad, occupying the whole of the enlarged top portion of the column. *Ovary* 4-5 × 3 mm., maroon, 6-keeled with alternate low and high ridges. *Capsules* 18 × 6 mm., elliptic, maroon.

Flowering : May to June. *Leaves :* July to November.

Occurrence in Bombay State : W. GHATS : Khandala, *Blatter* 35235 ; *Cooke* ; *Santapau* 634, 643, 824, 2036-2037, 2060, 4510, 4515, 6812, 9140, 18843 ; *Kapadia* 520, 582, 1228-1230 ; Lonavla, *Kapadia.* N. KANARA : Yellapur, *Santapau* 18709 ; *Sedgwick* 6066 *A.*

Distribution : Konkan, W. Ghats, N. Kanara.

Notes : Blatter & McCann described this species but did not cite any specimens actually examined by them. In the circumstances a *neotype* must be selected for the taxon [Art. 7 (3), *Int. Code Bot. Nomencl.* edit. 1956]. There are two old specimens in Blatter Herbarium ; one is *Blatter* 35235 (from Khandala), the other is a flowering plant, *Sedgwick* 6066 *A* (from Yellapur). These might possibly be counted among the original collections, but were not cited as such by the authors. We select, then, *Sedgwick* 6066 *A* as the *neotype* for *Nervilia infundibulifolia* Blatt. & McC.

As Santapau has pointed out, there is no distinctive feature which can separate *N. hallbergii* Blatt. & McC. from *N. infundibulifolia* Blatt. & McC. After a very careful study of the descriptions of the two species, we have come to the conclusion that they are identical. Since the latter species is much more fully described and also figured, we adopt *infundibulifolia* Blatt. & McC. as the epithet for this species, in accordance with Art. 57 of the Code.

This species is usually found under dense shade, in loose, moist soil.

2. **Nervilia monantha** Blatt. & McC. in Journ. Bombay nat. Hist. Soc. 35 : 724, 1932.

Tubers 12-22 mm. in diam., subglobose with several root-knobs. *Leaf* broadly funnel-shaped on opening, later spreading on the ground, appearing after the flowers ; petiole 2-4 cm. long ; lamina 2-12 cm. in diam., orbicular-cordate or subreniform, uniformly green, subplicate and velvety with short, glandular, greenish-white hairs on the upper surface, glabrous below ; the hairiness is more prominent when the leaf is freshly expanded. *Scape* 5-10 cm. long in flower, up to 25 cm. in fruit, 1-flowered, pale pink with 2-3 acute or subacuminate pale-pink, wide-mouthed sheaths. *Flowers* erect on opening, becoming suberect, then at maturity nodding and deflexed. *Bracts* small, triangular, acute, about 2 mm. long. *Sepals* and *petals* similar, greenish white, often rose tinted, linear-oblanceolate, broader above the middle, tapering to the base, entire, acute ; midnerve subcarinate below, with 1-2 pairs of faint lateral nerves. *Sepals* 17-22 × 3-5 mm., sub-concave. *Petals* slightly shorter and narrower. *Lip* 18-20 mm. long, scarcely saccate, more or less tubular, obscurely 3-lobed ; lateral lobes connivent around the column, narrow-oblong, entire; midlobe 3-4-lobulate, lateral lobules entire or subentire, slightly divergent, the middle one obscurely 2-lobed or entire, much wrinkled, subfimbriate in the sinuses between the lateral lobules. *Lip* pale pink, white at the base with 3 main nerves at the centre giving off papillate, purplish, hairy outgrowths on the midlobe, the lateral nerves on the midlobe also somewhat hairy. *Column* 7-9 × 2 mm., broad and clavate, flat in front, rounded behind, glabrous, walls of the clinandrium denticulate. *Anther* 2 × 1.5 mm., squarish. *Ovary* 5 × 2 mm. long, oblong-ovoid ; pedicel 2 mm. long, curved. *Capsules* 21 × 7 mm., decurved, broadly fusiform, 6-ribbed ; beak 5-7 mm. long.

Flowering : June. *Leaves :* July to December.

Occurrence in Bombay State : N. KANARA : *Bell* 4073 ; Dandeli, *Kapadia* 1690; Yellapur, *Bell*; *J. Fernandes* 1627 ; *V. Patel* 1845; *Kapadia* 1967, 1987, 2010-2015, 2213, 2242, 2344-2345; Nagargali, *Sedgwick ;* Karwar, *Bell.*

Distribution : Apparently endemic in N. Kanara.

3. **Nervilia juliana** (Roxb.) Schltr. in Bot. Jahrb. 45 : 402, 1911 ; Blatt. & McC. 726. *Epipactis juliana* Roxb. Fl. Ind. 3 : 453, 1832. *Pogonia juliana* Wall. Cat. 7399, 1832, nom. nud. ; Hook. f. 119.

Tuber 10-15 mm. in diam., orbicular, warted with 2 or 3 transverse bands. *Scape* 1-flowered, 7-9 cm. tall, erect ; sheaths 2-3, oblong, acute, the uppermost much dilated. *Flower* 30-35 mm. long, bracteate, very shortly pedicellate. *Bracts* 12-15 mm. long, erect, oblong, acute, somewhat cymbiform, longer than the ovary. *Sepals* 28-33 × 3 mm., straight (rarely curved), lanceolate, acute, entire, 5-nerved ; midnerve keeled below. *Petals* 25-28 × 2-3 mm., lanceolate, acute, 3-nerved. *Lip* 30-32 mm. long, very slightly saccate at the base, 3-lobed ; lateral lobes 15 × 2 mm., falcate, subacute, connivent with the column and concealing it, only the anther projecting beyond ; midlobe 13-15 × 7 mm., rhomboid or rhomboid-obovate, acute, entire or rarely subundulate, pubescent within.

The leaf and the colour of flowers are given by Blatter & McCann as follows : ‘ Leaf solitary, developing after the flowering of the scape, petioled, broadly ovate-cordate, acute, about 5 cm. in diameter, membranous, plicate with 5-7 veins radiating from the top of the petiole, green or purplish beneath ; . . . sepals and petals green ; lateral lobes white ; terminal white mottled with pink . . . ’

Flowering : March (Assam).

Occurrence in Bombay State : N. KANARA : *Bell.*

Distribution : India : Assam, Lower Bengal, N. Kanara. *World :* Ceylon, India, Burma.

Notes : The description has been drawn up from *Collect* 199, from the Naga Hills; the specimen was kindly loaned by the National Herbarium, Calcutta.

4. **Nervilia discolor** (Bl.) Schltr. in Bot. Jahrb. 45: 403, 1911; Holttum 105, f. 16e; Santapau in Proc. nat. Inst. Sci. India 24B: 139. *Cordyla discolor* Bl. Bijdr. 417, 1825. *Pogonia discolor* Blume, Mus. Bot. Lugd.-Bat. 1: 32, 1849, & 128, t. 57, 1858; J. J. Smith 54, f. 33. *P. biflora* Wight, Icon. 5(1): 22, t. 1758, 1851; Hook. f. 119. *Nervilia biflora* (Wight) Schltr. in Bot. Jahrb. 45: 403, 1911; Fischer 1459; Blatt. & McC. 726. (See Plate XXXII).

Tubers 1-3 cm. in diam., globose to oval, with a few rootlet knobs and 2-4 transversely circular bands. *Leaf* appearing just after the flowers, flat on ground and spreading; petiole 3-4 cm. long, arising from one end of the tuber, and giving rise to 2 stolons just below the lamina; lamina 4-16 × 5-16 cm., ovate-cordate, rounded, acute or subacuminate, plicate; margins with stiff hairs; upper surface pale green to dark green-purple with many prominent purple or green nerves and an equal number of depressed ones in between, hairy all over; hairs 1-2 mm. long, purple or pale green, stiff, in rows parallel to and on the nerves; lower surface pale green to light mauve-purple with smaller and fewer hairs similar to the ones above. *Scape* 4.5-17 cm. long, up to 30 cm. in fruit, brownish mauve, longitudinally striated with deeper colour, greenish white below, sheathed, sparsely tubercled, sheaths 2-3, the lowermost subterranean and colourless, enclosing part of the foliar bud at the base; the upper ones 2.5-3.5 cm. long, brown-mauve tinged with green, about 9-nerved, oblong acute, glabrous. *Flowers* 2 at the apex of the scape, one slightly below the other, nodding, 20-25 mm. long. *Bracts* 3-8 × 1-4 mm., ovate-lanceolate to subulate, acute, entire or very slightly toothed at the apex, faintly 1-3-nerved, glabrous, brown-maroon tinged with green. *Pedicels* 5 × 1 mm. pale purple, faintly ribbed. *Sepals* and *petals* spreading, brown-mauve, oblong-lanceolate, acute, entire, glabrous, sparsely gland-dotted; sepals 20-27 × 4-5 mm., midnerve prominent below. *Petals* 23-24 × 3-4 mm., 7-nerved. *Lip* 18-20 × 11 mm., obovate-oblong or nearly elliptical, shallowly 3-lobed, slightly saccate at the base, convolute round the column, the tube narrowest a little above the base, widening outwards, opening just beyond the column; lateral lobes very small, entire, obtuse, purple-veined; midlobe 6 × 6 mm., oblong or oblong-ovate, obtuse, narrowly emarginate, faintly crisped and crenulate; midnerve swollen and prominent, impressed on the underside. Colour of lip rose-mauve with deeper lateral veins, the midnerve on the midlobe much paler or white. *Column* 10-12 × 4-5 mm., erect, pale rose-pink, sigmoidally curved, clavate at the apex, shallowly grooved in front. *Anther* rose-pink, red in front, somewhat square; pollinia oval, in 2 masses. *Stigmatic surface* 3 × 2 mm., broadly funnel-shaped. *Ovary*

5×3 mm., oblong-orbicular, brownish maroon, with 3 strong and 3 shallow ridges. *Capsules* fusiform, 10-16×6-8 mm., ribbed, winged along the ribs; generally only 1 fruit develops.

Flowering : May to June. *Leaves :* June to November.

Occurrence in Bombay State : DANGS : Waghai, *Santapau* 19136-19140, 19206-19207; *Kapadia* 671, 1254-1259, 1409-1411; Pimpri, *Santapau*; *Kapadia.* DECCAN: Bhimashankar, *Kapadia* 1464-1467. N. KANARA : Yellapur, *Bell* 6066 (excluding A); *Kapadia* 2017-2018; Sirsi, *Bell*; *Santapau* 18660.

Distribution : India : Dangs, Deccan, N. Kanara, S. India. *World*: India, Malaya, Java.

Notes : From the literature, *N. biflora* Schltr. and *N. discolor* Schltr. seem to be identical; the only point of difference seems to lie in the raised, median band of lip (the midnerve) which is yellow in the latter and white or pale rose-coloured in the former species; the basic floral structure (including the position of the individual floral parts) is identical, and, therefore, we have fused the two species under the earlier specific epithet, *discolor* of Blume.

The colour scheme of this species is strikingly variable. In dense undergrowth, where little light reaches the forest floor, leaves are deep purple to almost black in colour with deep purple stiff hairs. With an increase of light, leaves turn brownish, often somewhat rusty-brown in colour. We collected tubers from dense forest in the Dangs (where the leaves were purple) and planted them in St. Xavier's College garden ; they gave pure green leaves with pale green hairs. Leaves collected from Bhimashankar in a rather open habitat were also green. It would seem, then, as if the deep colour of our Dangs plants was intimately connected with light intensity; as to the colour of the flowers themselves, we have noted sepals and petals in the Dangs as brownish mauve; Blatter & McCann recorded that in Yellapur they were brownish yellow with a green shade. Malayan plants have them pale olive-green to dull purplish, the veins of the lip being yellow to brown or purplish, the midnerve itself being yellow.

This species is locally known as *Dukkarkand* in the Dangs Dist., and is used to promote lactation in women.

5. **Nervilia aragoana** Gaud. in Bot. Voy. Freycinet 422, t. 36, 1826 ; Fischer 1459 ; Blatt. & McC. 729 ; Holttum 105, f. 16 d ; Santapau in Fl. Purandh. 128. *Pogonia flabelliformis* Lindl. [in Wall. Cat. 7400, 1832, nom. nud.; et] Gen. Sp. Orchid. 415, 1840 ; Hook. f. 121 ; Prain 1026; J. J. Smith 57, f. 36 ; Duthie 158, t. 125 ; Haines, Bot. Bih. Or. 1163, 1924. *P. nervilia* Bl. Mus. Bot. Lugd.-Bat. 1 : 32, 1849 ; & 130, t. 56, 1858. *P. carinata* Wight, Icon. 5 (1) : 15, t. 1720, 1851. *P. scottii* Reichb. f. in Flora 276, 1872 ; Hook. f. 120, et in Ann. R. Bot. Gard.

Calcutta 5 : 62, t. 93, 1895 ; King & Pantl. 269, t. 360 ; Prain 1026. *Nervilia scottii* (Reichb. f.) Schltr. in Bot. Jahrb. 45 : 404, 1911.

Tuber 1.5-2 cm. in diam., subglobose, white, with parallel lines along the circumference dividing into obscure lobes. *Leaf* appearing after the flowers, erect, petiolate. *Petiole* 8-20 cm. long, purple turning light green with purple lines ; generally 2 stolons arise on opposite sides from the petiole just above the tuber. *Lamina* 9-12 × 8-11 cm., cordate, broadly ovate to almost orbicular, acute, acuminate or apiculate, glabrous, dark green above, pale green below ; nerves up to 18 in number. *Scape* 10-25 cm. tall, 2-sheathed, green above, light purple below ; lower sheath 2 cm. long, white with brown streaks, loose, acute ; upper sheath about 2 cm. long, closely fitting round the peduncle, similar to the lower one. *Raceme* few- to many-flowered, lax. *Flowers* drooping, green, shortly stalked, about 20-25 mm. long. *Bracts* 14 × 2 mm., decurved, linear-lanceolate, subacuminate, glabrous, light green, faintly tinged with purple. *Pedicels* 3 mm. long, green, curved. *Sepals* 17-25×2-4 mm., green or yellowish green, oblanceolate, acute or subacute, entire, glabrous, often the midnerve subcarinate below, the lateral pair of nerves fainter. *Petals* 14-25×2-5 mm., green, similar to sepals, often narrower at the base. *Lip* 17-24 mm. long, subsaccate and subclawed at the base, obovate in outline, 3-lobed, lateral lobes erect, 1-3 mm. broad, parallel and embracing the column; narrowly oblong, acute or obtuse, pale green ; midlobe 4-6 × 5-7 mm., variable in shape, not constricted or deflexed, obtuse or subacute, irregularly crenulate, somewhat crimped with incurved edges, pale yellowish green, nerves red-pink, parallel, subwavy along the midlobe. The 3 central prominent nerves along the entire length of the lip are yellowish green, minutely hairy, the pubescence extending to some of the lateral nerves also. *Column* pale green, 7-10 mm. long, dilated above, placed at an angle to the ovary. *Anther* posticous, white above, reddish towards the base ; midnerve red-purple. *Stigmatic surface* fairly broad, circular trapezoid. *Ovary* 4-5 mm. long, drooping, green often flushed with pink, the ridges often winged.

Occurrence in Bombay State: DANGS : Waghai, *Santapau* 19141 ; Dungarda, *Santapau* 19280. KONKAN : Bombay, cultivated, *Kapadia* 1357, 1917-1920 ; Neral, *Blatter* ; Tansa, *Santapau* 2706 ; Borivli, *Santapau* 2343-2344, 15026 ; *R. Fernandez* 1287, 1816-1817, 1838-1839, 1862 ; *Herbert* 2348 ; *Kapadia* 1244-1247 ; Wajreshwari, *Kapadia* 1293-1294 ; Mumbra, *Shenoy* 3462, 3641-3642, 3656, 3667 ; Badlapur, *Kapadia* 1284, 1288 ; Karjat, *Irani* 90 ; *Kapadia* 1217-1218, 1239. DECCAN : Purandhar, *Santapau* 7130, 7246, 7248, 7254, 7263 ; *Kapadia* 1316. N. KANARA : Yellapur, *Kapadia* 2233-2235 ; Sampkhand, *Sedgwick & Bell* ; Guddehalli, near Karwar, *Kapadia* 2127.

Distribution : India : Tropical Himalayas from Garhwal (1400 to 1600 m.) eastwards to Kumaon, Bengal, southwards to Saurashtra, Dangs, Konkan, Deccan, N. Kanara, Mysore, Rampa and Pulney hills, and Travancore. *World :* India, Malaya, and Java.

Notes : This species is often found under clumps of *Euphorbia neriifolia* Linn. in open fields and around bamboo clumps in forests.

From the descriptions and plates of Hooker f. (in *Ann. R. Bot. Gard. Calcutta* 5 : 62, t. 93, 1895) and King and Pantling, *Pogonia scottii* Reichb. f. seems to be identical with *N. aragoana* Gaud. The latter is a very variable species with respect to the shape of the lip. uthie mentions that the leaves, at least the younger ones, are hairy on the margins, and the midlobe, as figured in his t. 125 and described in the text, is supposed to be deflexed from the general upward rising of the lip. These characters are not in agreement with our observations and those of others. The leaves are completely glabrous and the midlobe is not deflexed.

6. **Nervilia carinata** (Roxb.) Schltr. in Bot. Jahrb. 45 : 406, 1911 ; Fischer 1459 ; Blatt. & McC. 729. *Epipactis carinata* Roxb. Fl. Ind. 3 : 454, 1832 ; Graham, Cat. Bomb. Pl. 205, 1839. *Pogonia carinata* Lindl. Gen. Sp. Orchid. 414, 1840 ; Dalz. & Gibs. Bomb. Fl. 270, 1861 ; Hook. f. 121, et in Ann. R. Bot. Gard. Calcutta 5 : 62, t. 94, 1895 ; Prain 1026 ; Duthie 159, t. 124, et Fl. Upp. Gang. Pl. 3 : 217, 1920 ; Cooke, Fl. Pres. Bomb. 2 : 707, 1907.

Leaves similar to those of *N. aragoana* Gaud. ; authors do not seem to be in agreement about the characters of the leaves of this species ; Hooker f., Duthie, etc., give the leaves as 7-9-nerved, and this number is said to be distinctive of the species ; Hooker f., however, in *Ann. R. Bot. Gard. Calcutta* states that the number of nerves is 7-9-12. As for size, leaves are said to be 3.8-6.4 cm. wide ; but these figures seem rather low and probably refer to young, not yet fully developed leaves. *Scape* 10-17 cm. long, 2-sheathed, bearing a terminal lax raceme of few flowers ; sheaths 2-4 cm. broad, oblong, obtuse. *Flowers* 18-22 mm. long, drooping. *Bracts* 6-8 mm. long narrowly linear-lanceolate, acute, somewhat erect ; *pedicels* 3-4 mm. long. *Sepals* and *petals* 19-21 × 3-4.5 mm., oblanceolate, acute, entire, the midnerve prominent below with a pair of fainter lateral nerves ; petals slightly shorter than sepals, narrower in the lower third portion. *Lip* 20-21 mm. long, 3-lobed, not saccate, subclawed at the base, rhomboid in outline ; lateral lobes 2-2.5 mm. broad, subacute, narrowly oblong ; midlobe ovate or rhomboid-ovate, slightly constricted at the base, tapering to an acute or subacuminate apex, irregularly crenulate ; disc 3-nerved, sparsely pubescent. *Column* 9 mm. long, subclavate and slightly curved at the apex, strongly carinate along the back, the column being trigonous. *Ovary* 5 mm. long, strongly ridged, ovoid.

Flowering : June.

Occurrence in Bombay State: W. GHATS : Khandala, *Santapau* 4501-4502. N. KANARA : Dharwar, *Law* ; Kulgi, *Bell.*

Distribution : India : Sub-Himalayan tracts of Rohilkhand and N. Oudh, Kumaon, Bengal, Konkan, W. Ghats, N. Kanara, Mysore, Pulneys, Cochin. *World :* India, Burma.

Notes : Very similar to, if at all distinct from, *N. aragoana* Gaud. Duthie stresses the number of nerves on the leaf, the erect bracts and the shape of the midlobe of lip as typically distinguishing this species from *N. carinata* ; these points appear far from clear on examination of the actual specimens.

Prain separates the two species thus : Midlobe ovate, acute, crenate, white with red or purple veins = *carinata* ; Midlobe ovate, acute, pure white = *aragoana.* All our specimens show a white or greenish-white, rarely yellowish lip, with various shades of red or purple or brown on the veins.

In our opinion, the only more or less constant features on which *N. carinata* Schltr. can be separated from *N. aragoana* Gaud. are : in *carinata* the floral bracts are erect, the lip is neither saccate nor gibbous ; the midlobe of the lip is narrow at the base, ovate and acute to acuminate. To judge from the descriptions of this plant, the diagram of Hooker f. in *Ann. R. Bot. Gard. Calcutta* 5 : t. 94, seems to represent the present plant correctly ; our Khandala plants are very close to Hooker's plant.

Nevertheless, the position of *N. carinata* Schltr. remains rather doubtful.

Imperfectly known Species

1. **Nervilia hispida** Blatt. & McC. in Journ. Bombay nat. Hist. Soc. 35 : 728, 1932.

This species was described from T. R. Bell's manuscript notes.

According to Blatter & McCann, the species is distinguished from *N. aragoana* Gaud. by its leaf being much smaller and densely hispid, the hairs being minute, white and tubercular ; the scape is shorter and the flowers several, smaller and appearing with the leaves ; the base of the lip is somewhat saccate. From *N. carinata* Schltr. it is distinguished by the much longer petiole, and the hispid, many-nerved leaf.

Flowering and *Fruiting :* June.

Occurrence in Bombay State: N. KANARA : Yellapur, *Bell.*

2. **Nervilia plicata** (Andr.) Schltr. in Bot. Jahrb. 45 : 403, 1911 ; Blatt. & McC. 727 ; Santapau 304. *Arethusa plicata* Andr. Bot. Rep. t. 321, 1803. *Epipactis plicata* Roxb. Fl. Ind. 3 : 454, 1832. *Pogonia plicata* Lindl. Gen. Sp. Orchid. 415, 1840 ; Hook. f. 119 ; King & Pantl. 268, t. 358 ; Cooke 707.

We have not seen any specimen which may, with certainty, be said to belong to this species; hence we give the original description of Andrews:

'*Generic Character.* Calyx sheath leafy. Cup none. *Blossom* gaping. Five petals oblong, nearly equal, 2 outer, all converging into a helmet. *Honey-cup* one leaved, tubular at the base, within the bottom of the blossom two-parted; lower lip reflexed, broad, wrinkled, the length of the petals, hanging down forwards, upper lip linear, very delicate, fixed to the shaft, lobed at the top. *Stamens* 2 threads, very short, fitting on the top of the pointal (pistil). Tips egg-shaped, flattened covered by the folding of the inner lip of the honey-cup. *Pointal* (pistil) seedbud oblong, beneath. Shaft oblong, incurved, clothed by the inner lip of the honey-cup. *Stigma* funnel-shaped. *Seed-vessel* capsule oblong, egg-shaped, one celled, 3-valved, splitting at the angles. *Seeds* numerous, chaffy. *Specific Character.* Arethusa with a globular root; leaf heart-shaped, hairy.'

Flowering : July.

Occurrence in Bombay State : KONKAN : Bombay, *Millard.*

Distribution : India : Konkan (?), W. Ghats (?), Bengal (?), Sikkim (?). *World :* India, Philippines.

Notes : N. plicata Schltr. (= *Pogonia plicata* Lindl.) as described in our provincial floras seems to be quite a different plant from *Arethusa plicata* Andr., which is the basionym of both Schlechter and Lindley; the descriptions seem to agree with *N. discolor* Schltr. We feel quite sure about the characteristics of the latter plant, but are rather doubtful about those of *N. plicata.* To add to these doubts, we have studied Cooke's specimens in Kew Herbarium and in Poona, collected from Khandala; such specimens do not agree with the description and diagram of *Arethusa plicata* Andr., but with *N. infundibulifolia* listed above. The plant mentioned as *N. plicata* in our floras is *N. discolor* Schltr. and not *N. plicata* Schltr. nor *Arethusa plicata* Andr.

MALAXIS Soland. ex Sw.

MALAXIS Soland. ex Sw. Prodr. Veg. Ind. Occ. 119, 1788, non Swartz 1789 nec auct.; O. Kuntze, Rev. Gen. Pl. 2 : 672, 1891; Correl, Nat. Orch. N. America 255, 1950; Holttum, Rev. Fl. Malaya 1 : 191, 1953. *Achroanthes* Rafin. in Amer. Monthly Mag. Crit. Rev. 4 : 195, 1819. *Microstylis* (Nutt.) Eaton, Man. Bot. North Am. (ed. 3) 115, 347, 353, 1822; Lindl. Orchid. Scel. n. 18, 1826; Endl. Gen. Pl. 189, 1837; Benth & Hook. f. Gen. Pl. 3 : 494, 1883; Ridley in Journ. Linn. Soc. (Bot.) 24 : 308; Pfitz. in Engl. & Prantl, Pflanzenf. 2 (6) : 130, 1880; Hook. f. Fl. Brit. Ind. 5 : 686, 1890; King & Pantl. in Ann. R.

Bot. Gard. Calcutta 8 : 14, 1898 ; Duthie, ibid. 9 (2) : 87, 1906 ; J. J. Smith, Fl. Buitenz. 6 : 247, 1905 ; Schltr. Orchid. 155, 1927.

The generic name *Malaxis* is a Greek word meaning *softness* or *tenderness*, probably in allusion to the soft texture of the leaves, or may be with reference to the delicacy of the entire plant.

Terrestrial, rarely epiphytic or lithophytic *herbs*. *Stems* creeping, with erect leafy apex ; or short, fleshy and close together, bearing few to many leaves. *Leaves* broad, often unequal-sided at the base, thin, more or less plicate, inarticulate, sheathing at the base. *Inflorescence* terminal, in few- to many-flowered subumbellate racemes, or in an elongated raceme of small flowers. *Sepals* free, or the lateral ones more or less connate, spreading. *Petals* ovate-lanceolate to narrowly linear or filiform, often strongly coiled. *Lip* sessile, superior, erect or spreading, entire or 3-lobed, concave to saccate, often with a hollow near the base, usually with 2 large lobes (called auricles) close to the sides of the column and extending downwards below it, the apex often toothed. *Column* very short, terete, hollowed on top, often toothed at the apex, with or without fleshy arms. *Anther* terminal, sessile, erect on the back of the column, its tip pointing upwards ; pollinia 4, waxy, ovoid, free or cohering in pairs to a viscid mass. *Capsule* small ovoid, ellipsoid.

This genus consists of about 250 species distributed in the warmer parts of the World, extending into North Temperate regions. It attains its maximum development in Asia and Oceania ; it is also widely distributed in the Western Hemisphere.

Bentham & Hooker f. attribute the name *Malaxis* to Swartz in *K. Vet. Acad. Nya Handl.* 21 : 233, 1800, where Swartz published the species *M. paludosa* (L.) Sw. ; O. Kuntze, however, has pointed the existence of an earlier homonym, *Malaxis* Swartz, *Prodr. Veg. Ind. Occ.* 119, 1788, with two species *M. spicata* and *umbellifera* Sw. In the opinion of O. Kuntze, *Malaxis* Sw. 1800 is the same as *Malaxis* of Bentham & Hooker f., but is different from *Malax*is Sw. 1788. The name *Hammarbya* was proposed by O. Kuntze for *Malaxis* Sw. 1800; and this has been accepted by Summerhayes (in *Wild Orch. Britain* 315, 1951) and other recent authors, with *H. paludosa* O. Kuntze as the only species.

In most of the earlier works the generic name *Microstylis* is attributed to Nuttal, 1818 ; this is not correct, for Nuttal made *Microstylis* a section of *Malaxis*. The first author to treat *Microstylis* as a generic name is undoubtedly Eaton (1822), and not Lindley (1826) as stated by O. Kuntze.

KEY TO THE SPECIES OF *MALAXIS* OF BOMBAY

1. Leaves flat and spreading on the ground, sub-coriaceous and subplicate ; inflorescence lax ; petals involute behind the large lip, hardly visible ; side lobes of lip produced upwards into acute or obtuse auricles, the apex bilobed .. .. *mackinnonii*
1. Leaves erect, not flat on the ground, membranous, much plicate ; inflorescence dense ; petals not involute, clearly visible in flower ; sidelobes of lip not produced upwards into auricles, the lip somewhat suborbicular, reniform, pectinate :
    2. Stem stout, not pseudobulbous at base ; leaves 5-18 cm. long, with a petiole 2-6 cm. long .. .. .. *versicolor*
    2. Stem slender, much swollen and distinctly pseudobulbous at base ; leaves 2.5-7 cm. long, sessile or nearly so .. *densiflora*

ENUMERATION OF THE SPECIES OF *MALAXIS* OF BOMBAY STATE

1. **Malaxis mackinnonii** (Duthie) Ames in Orchid. 6 : 289, 1920. *Microstylis mackinnonii* Duthie in Journ. As. Soc. Bengal, II. 71 : 37, 1902, et in Ann. R. Bot. Gard. Calcutta 9 (2) : 88, t. 95, et Fl. Upp. Gang. Pl. 3 : 184, 1920. *Microstylis cardonii* Prain, Beng. Pl. 1004, 1903, et in Journ. As. Soc. Bengal, II, 73 : 189, 1904 ; Haines, Bot. Bih. Or. 1165, 1924 ; Mooney, Suppl. Bot. Bih. Or. 210, 1950.

Terrestrial *herbs*. *Tuber* small, corm-like, 7-10 mm. in diam., whitish. *Leaves* 1-3, clustered and spreading on the ground, subfleshy, subplicate, green or purplish on the under surface, continued below the ground level into a sheath which is more or less rigid, greyish, 1-4 cm. long ; lamina 3-13 × 1.3-7 cm., variable in shape, oblong-lanceolate, elliptic, oblong, ovate-lanceolate, or broadly ovate to rarely suborbicular, acute or obtuse, entire, about 5-9-nerved, the nerves often purplish below. *Scape* together with the raceme 12-40 cm. long, erect, subflexuose, yellowish green, angled, often slightly winged, rarely much thickened towards apex. *Flowers* 3-4 mm. across, pale yellow or yellowish green. *Bracts* 4 × 1-1.5 mm., deflexed, pale yellowish green, narrowly subulate, subacuminate or acute, entire, 1-nerved. *Sepals* 2.5 × 1.5 mm., narrowly oblong, obtuse with the entire margins folded backwards, 3-nerved, pale yellowish green to yellow. *Petals* 1.5-2 mm. long, very narrowly linear to filiform, obtuse, twisted and much reflexed, normally not visible in the flower, 1-nerved, pale yellow. *Lip* 5-5.5 mm. long, pale yellow, superior, ovate-oblong in outline, somewhat constricted just beyond the middle ; basal portion 3.5 × 3 mm., suborbicular with the auricles about 1.5 mm. long, obtuse or acute, concave in the middle about the attachment of the column, again convex on the sides outwards ; the apical part 2 × 2 mm., broadly ovate-oblong, slightly curved forwards, somewhat hooded, bilobed at the apex with a narrow sinus in between, the lobes obtuse. *Column* about 1 mm. long, pale yellow, with fleshy rounded arms. *Anther* minute, broader than long or suborbicular ; pollinia 4, in pairs, ovoid-pyriform. *Pedicel* with the *ovary* 2-3 mm. long, pale greenish yellow, ribbed. *Capsules* 10 × 4 mm., erect, obovoid, ridged, greenish yellow ; stalk 2-3 mm. long.

Flowering : August to September. *Fruiting :* September to November.

Occurrence in Bombay State : DANGS : Waghai, *Santapau* 19088, 19142, 20000 ; *Kapadia* 688, 1421-1428.

This orchid has been recorded for the first time in Bombay State.

Distribution : N. W. Himalaya 1800 to 2000 m., Upper Gangetic Plain, Bengal, Chota Nagpur, southwards to the Dangs District.

Notes: This species is locally abundant in open patches of forest, usually around bamboo clumps.

We have checked our specimens with Mackinnon's specimens in the National Herbarium, Calcutta, on which Duthie based his *Microstylis mackinnonii.* Except for the absence of the slight purple coloration in the flowers, our specimens are identical with the ones in Calcutta.

Microstylis cardonii Prain seems to be identical with *Malaxis mackinnonii* (Duthie) Ames. Further, both Duthie and Prain point out the similarities in the floral structure of their plants to *Microstylis wallichii* Lindl. ; but the structure and position of the leaves at once distinguish these two plants.

2. **Malaxis versicolor** (Lindl.) Sant. & Kapadia, comb. nov. *Microstylis versicolor* Lindl. Gen. Sp. Orchid. 21, 1830 (non Wight 1844-45); Ridley 343 (excl. syn. *Malaxis rheedii* Sw.); Cooke 678 ; Haines 1165, 1924; Fischer 1408 ; Blatt. & McC. 259. *Malaxis rheedii* Heyne ex Wall. Cat. 1939, 1828, nom. nud.; Graham, Cat. Bomb. Pl. 202, 1839. *Microstylis rheedii* Wight, Icon. 3 (2): 9, t. 902, 1844-1845; Dalz. & Gib. Bomb. Fl. 260, 1861 (excl. syn.); Hook. f. Icon. Pl. t. 1883, et Fl. Brit. Ind. 5: 690, 1890 ; Prain 1004 ; Gammie 565 ; Fyson, Fl. Nilg. Puln. Hill-Tops 384, 1915, et t. 510, 1920. *Liparis intermedia* A. Rich. in Ann. Sc. nat. ser. 2, 15: 17, 1841 (?). (See Plate XXXIII).

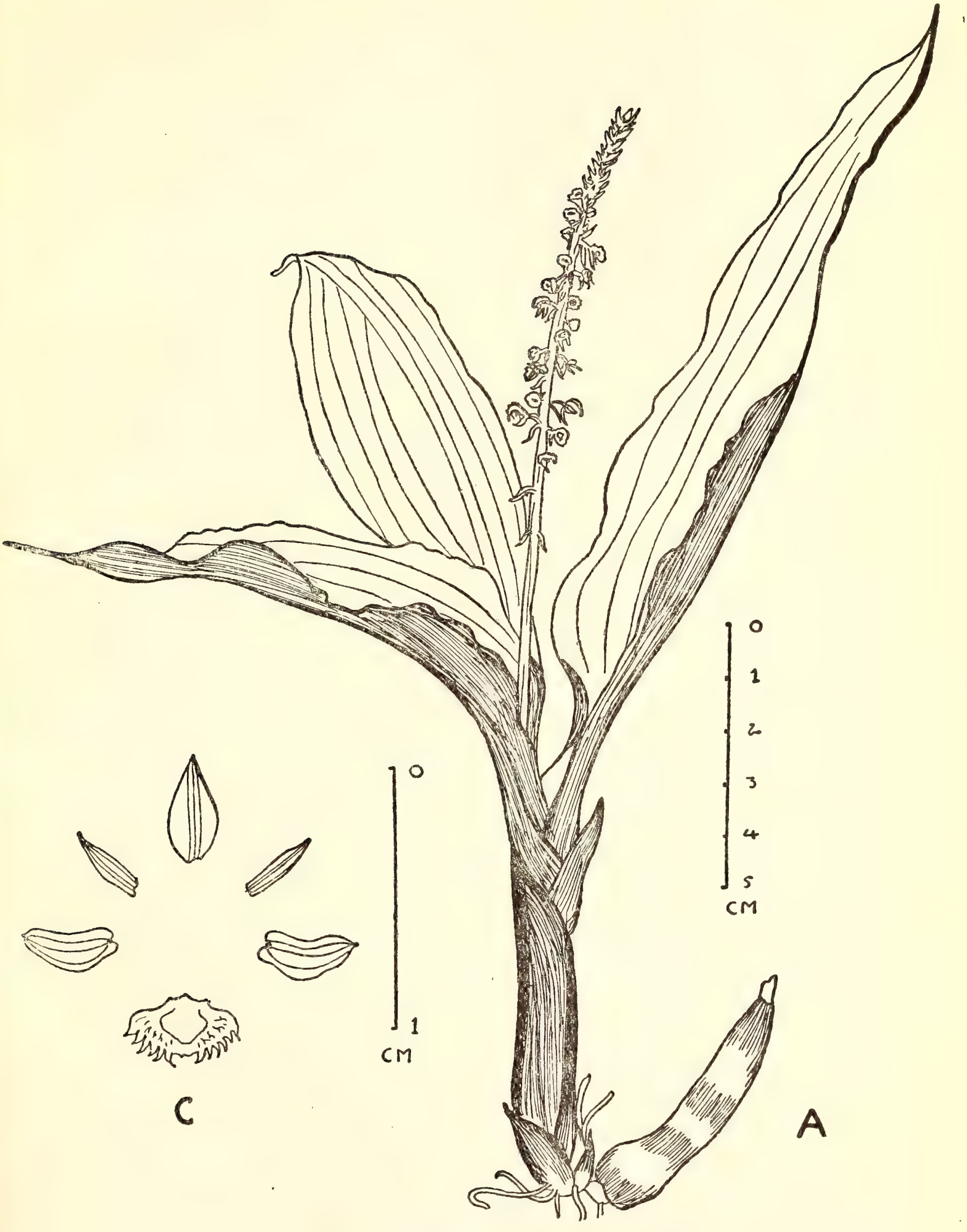
Terrestrial, lithophytic or rarely epiphytic *herbs. Stem* erect, 3-25 cm. tall, slightly swollen at the base, sheathed greenish-purple ; sheaths 2-5 × 1-1.5 cm., ovate-lanceolate, acute or acuminate, green-purple with 3-5 prominent purple nerves. *Leaves* 3-5, petiolate, sheathing plicate ; petioles 2-6 cm. long, amplexicaul, green-purple with a few purple nerves; lamina 5-18×2.5-11 cm., ovate-lanceolate or broadly ovate or elliptic-lanceolate, acute, glabrous, 8-10-nerved ; margins slightly crimped, denticulate ; nerves depressed above, prominent below, purple-green. *Inflorescence* 8-35 cm. high, dense or lax; peduncles 3-10 cm. long, angled, purple with a few bracts at the top. *Buds* green when young, turning yellowish to purple at maturity, ovate, obtuse, slightly curved. *Flowers* 4×4 mm., yellow with a pale purple tinge when young, becoming deep reddish purple with age, and again somewhat yellow on fading, pedicellate. *Bracts* 3.5×1-1.5 mm., erect and green in bud, deflexed and slightly purple at the base after anthesis, lanceolate, acuminate, entire. *Sepals* unequal, purple, obtuse, entire, 3-nerved; the dorsal one 4 mm. long, linear and reduplicate with a broad base; the lateral ones 3×1 mm., broadly ovate and conduplicate with a broad back, subfalcate. *Petals* 3.5 mm. long, purple, slightly curved, acute, entire and reduplicate. *Lip* superior through a twist of 180 degrees, 2.5×4 mm., purple, rounded, reniform and somewhat fan-shaped, pectinate except for a small portion in the middle ; teeth usually about 8-11, curved, pointing towards the centre; the claw small, concave, just opposite the column. *Column* about 1.5×1 mm., yellow, footless, somewhat constricted in the middle with 2 very short arms. *Anther* whitish, globose ; pollinia 4, waxy, in pairs, broadly ovoid. *Stigmatic surface* yellow, oblong-truncate. *Pedicel* with *ovary* 2-5 mm. long, deep brown-maroon, strongly ridged. *Capsules* 10×6 mm. obovate, pyriform.

Flowering : July to August. *Fruiting :* September to March.

Occurrence in Bombay State: KONKAN: *Law*; *Stocks*; Bombay, cultivated, *Kapadia* 1358; Hills west of Mulund, *McCann*; Matheran, *Chibber*. W. GHATS : Khandala, *Cooke* ; *Hallberg* ; *Blatter* 35233 ; *Blatter & McCann*; *Kapadia* 640-641; Lonavla, *Garade*; Panchgani, *Blatter*; Mahableshwar, *Cooke*; *McCann*; *Santapau* 11804-11805, 13197-13199, 13201, 13240; *Kapadia* 2086-2093. DECCAN: Koinanagar, *Kapadia* 2880-2883, 2902. N. KANARA : *Sedgwick* ; Yellapur, *Santapau* 18710 ; *Kapadia* 1983-1986, 2241 ; Castle Rock, *Kapadia* 2851-2853 ; Guddehalli, near Karwar, *Bell* ; *Kapadia* 2143-2144.

Distribution : India : Chota Nagpur, Konkan, W. Ghats of Bombay State and S. India, Deccan, N. Kanara. *World :* India, Ceylon.

Notes: The colour of the plant bears a striking relation to the kind of light under which it grows. The Khandala plants were green tinged with purple, with very deep purple prominent nerves, and the plant as a whole looked purplish. These plants were cultivated in St. Xavier's College garden, more or less under the open sky ; the new shoots given off from old stumps did not have the slightest trace of purple, leaves being pure green. Thus the purple coloration seems to be inversely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Malaxis versicolor Sant. & Kapad.

A. Plant in flower; C. Sepals and petals dissected.

proportional to the light intensity. This effect of light has been more clearly observed in the variations in the colour of the flowers. A number of plants were collected from spots with varying light intensity, from Mahableshwar : (1) In dense forest undergrowth ; (2) at the edges of dense forest ; and (3) along the road among shrubs. At (1) the spikes of flowers were deep purple ; at (2) the flowers were purplish tinged with greenish yellow ; at (3) the lowermost flowers, which were practically hidden in the shade were of a deep purple colour, the middle ones, receiving some light, were yellowish ; the uppermost, receiving the full sunlight, were pure green.

It is probably due to these variations in colour that Lindley gave the specific epithet *versicolor* to this species.

The nomenclature of this plant is complicated by the fact that two different plants have often been considered identical. O. Kuntze gives the following plants as specifically identical : *Malaxis resupinata* (Forst.) O. Kuntze (1891); *Malaxis rheedii* Sw.; *Epidendrum resupinatum* Forst.; *Microstylis versicolor* Lindl.

Hooker f. in *Icon. Pl.* t. 1883, distinguishes two plants : (a) *Microstylis rheedii* Wt. (= *Malaxis rheedii* Heyne ex Wall., non Sw. ; Rheede, *Hort. Mal.* 12 : t. 27), which is our Indian plant, and (b) *Microstylis plantaginea* (= *Malaxis rheedii* Sw., non Heyne ex Wall., *Epidendrum resupinatum* Forst.) ; this is a Javanese and Pacific Islands plant, not found in India.

It would seem, therefore, that if these 2 species are accepted as distinct, the oldest legitimate name for our plant is *Microstylis versicolor* Lindl. (non Wt.) and for this reason we herewith propose the new combination, *Malaxis versicolor* Sant. & Kapadia.

3. **Malaxis densiflora** (A. Rich.) O. Kuntze, Rev. Gen. Pl. 2 : 673, 1891. *Liparis densiflora* A. Rich. in Ann. Sc. nat. ser. 2, 15 : 18, t. 1 B, 1841. *Microstylis versicolor* Wight, Icon. 3 (2) : 9, t. 901, 1844-1845 (non Lindl. 1830) ; Hook. f. 691. *M. luteola* Wight, Icon. 5 (1) : 4, t. 1632, 1851 ; Ridley 345. *M. pratensis* Ridley in Journ. Linn. Soc. 24 : 344, 1888. *M. densiflora* (A. Rich.) Fischer in Gamble, Fl. Pres. Madr. 1409, 1928.

We have been unable to collect fresh flowers for detailed examination ; the following is the translation of A. Richard's original description : ' Pseudobulbs ovoid, sheathed ; leaves often in pairs, ovate, acute, sheathing at the base, 7-nerved, plicate, glabrous ; scape longer than the leaves, many-angled ; the spike many-flowered, very dense, 2-3 inches long ; the bracts lanceolate, acute, as long as the flowers ; the lip foveolate at the base, flabellate, its margins reflexed and fimbriate into narrow linear strips. Grows among grasses on the hills near Ootacamund and Dodabetta. Flowers from July to December.

Note : This species has rather small flowers, which are purple, at times very deep purple. It approaches near many species, which are already known, and, like the present one, native of India, among others *Liparis atropurpurea*, *L. nepalensis* ; from all these the present species is clearly distinguished by the beautiful spike and the lip that is concave in its lower part, the margins of which are reflexed and cut into deep, linear and narrow segments. Its flowers are very numerous and form a very dense spike.'

Fruiting : October.

Occurrence in Bombay State: N. KANARA : Sirsi, *Hallberg & McCann* 34975.

This species is not mentioned by Blatter & McCann in their Revision. It constitutes a new record for Bombay State.

Distribution : India : N. Kanara, W. Ghats of Madras State at high elevations. *World :* India, Ceylon.

Notes : This species is similar to *M. versicolor* Sant. & Kapad. from which it differs in being much smaller and more slender, and the base of the stem is swollen into a more or less distinct pseudobulb.

Notes on the Tuna and Frigate Mackerel from Ratnagiri[1]

BY

M. R. RANADE

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(*With one plate*)

Tuna fishery is being well exploited in countries like the United States of America, Japan, and Australia. Although potentialities exist for similar exploitation in India, our tuna fishing is conducted on a comparatively small scale. Six species of tuna have so far been recorded from the Indian Ocean: three by Day (1886), viz. *Euthynnus alletteratus affinis* (=*Thynnus thunnina*), *Katsuwonus pelamis* (=*Thynnus pelamis*), and *Neothunnus macropterus* (=*Thynnus macropterus*) ; one by de Beaufort (1951), viz. *Kishinoella tonggol* ; and two by Jones (1958), viz. *Auxis thazard* and *Auxis tapeinosoma*.

Ratnagiri, on the coast of Maharashtra State, is singularly fortunate in having a good tuna fishery which is of considerable importance to the local fishermen. During the course of investigation on this fishery off Ratnagiri, the following four species have, so far, been recorded :

Scientific Name	Common English Name	Vernacular Name
Euthynnus alletteratus affinis (Cantor)	Little Tuna	Bibya Gedar
Auxis thazard (Lacépède)	Frigate Mackerel	Gedari
Kishinoella tonggol (Bleeker)	Blue-fin Tuna	Khavalya Gedar
Neothunnus macropterus (Temminck & Schlegel)	Yellow-fin Tuna	Pimp

Of these four species nearly equal quantities of two species, viz. *Euthynnus alletteratus affinis* and *Kishinoella tonggol*, form more than nine-tenths of the total catch of tuna landed at Ratnagiri. It is reported by fishermen that specimens of Oceanic Skipjack, *Katsuwonus pelamis* (Linnaeus), are also occasionally found in Ratnagiri, but I have so far not come across any specimen of this species.

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[1] Communicated by Dr. C. V. Kulkarni, Director of Fisheries, State of Maharashtra.

As there is some confusion with regard to the identification of tuna fish, (Serventy, 1956), a field key is presented for the identification of different species of tuna found in the Indian Ocean, along with some notes on the variation in the number of gill-rakers in *Auxis thazard* and *Kishinoella tonggol.*

KEY TO THE IDENTIFICATION OF INDIAN TUNA (cf. Plate)

1. Scales confined to the fore part of the body (the corselet) and along the lateral line. Base of the first dorsal fin equal or longer than head .. .. ..
Fam. : KATSUWONIDAE

2. Body completely covered with scales and the base of the first dorsal fin shorter than head.. .. ..
Fam. : THUNNIDAE

Fam. : KATSUWONIDAE

3. Wide interspace between the first and second dorsal fins .. .. Genus : *Auxis* 5

4. The first and the second dorsal fins close together .. 7

5. Corselet having not more than four rows of scales in the band below the position of the second dorsal fin ..
Auxis thazard (Lacépède)

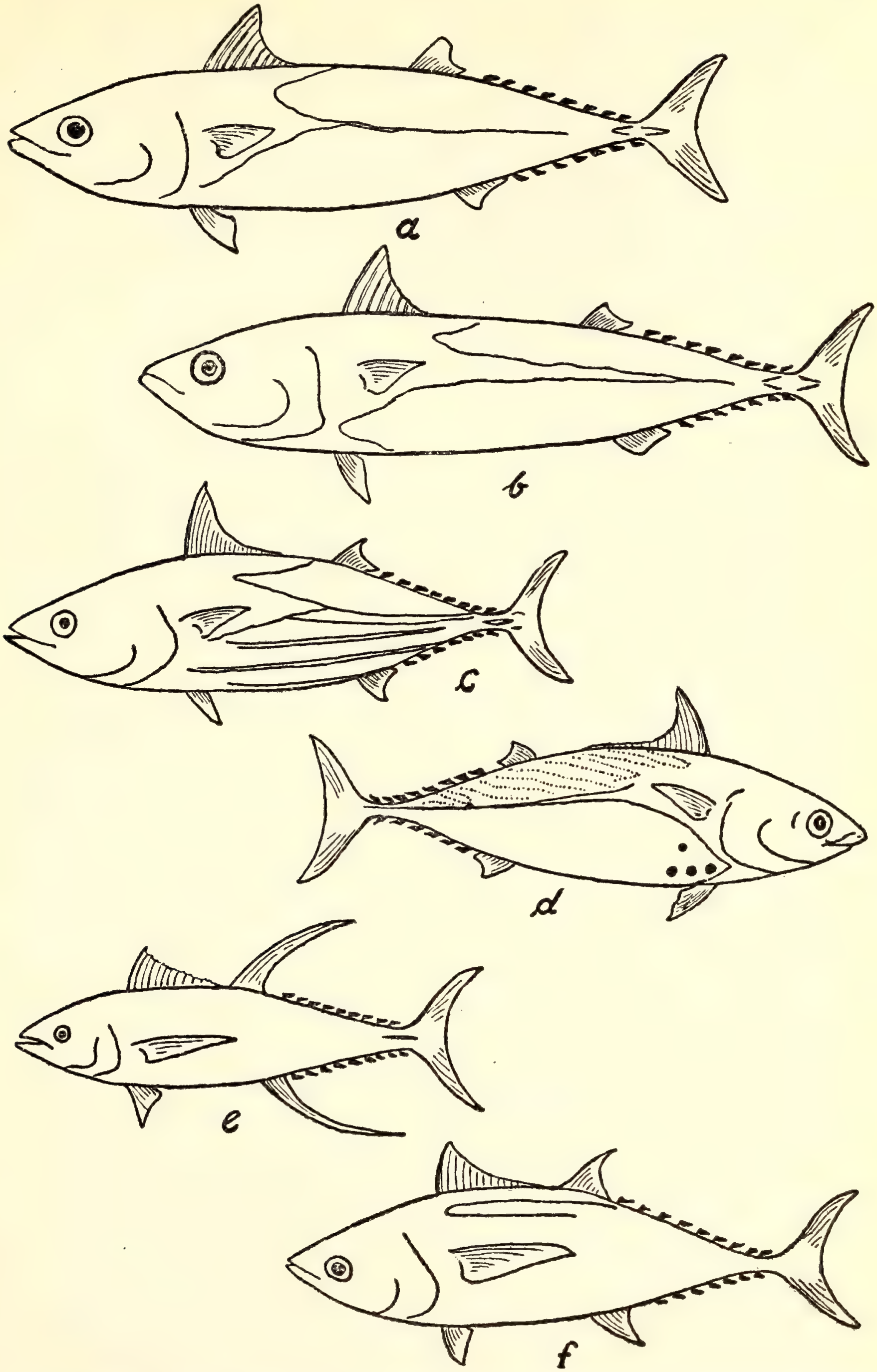
6. Corselet having 7 to 12 rows of scales in the band below the position of the second dorsal fin .. ..
Auxis tapeinosoma Bleeker

7. Four or five dark stripes along the sides and belly ..
Katsuwonus pelamis (Linnaeus)

8. Three to five black spots below the pectoral base ..
Euthynnus alletteratus affinis (Cantor)

Fam. : THUNNIDAE

9. Pectorals long, extending beyond the origin of the second dorsal fin. Air bladder present. Second dorsal and anal fin and finlets yellow .. .. ..
Neothunnus macropterus (Temminck & Schlegel)



a. *Auxis thazard* (Lacépède) ; b. *Auxis tapeinosoma* Bleeker ; c. *Katsuwonus pelamis* (Linnaeus) ; d. *Ethynnus alletteratus affinis* (Cantor) ; e. *Neothunnus macropterus* (Temminck & Schlegel) ; f. *Kishinoella tonggol* (Bleeker)

10. Pectorals short, reaching end of the first dorsal fin. Air bladder absent. Finlets yellow with grey edges .. *Kishinoella tonggol* (Bleeker)

Auxis thazard (Lacépède)

This species has a wide distribution in the warm seas of the Atlantic and Pacific Oceans. Previous records of this fish from the Indian Ocean are from Java and adjacent islands in Indonesia (de Beaufort, 1951), coasts of Natal and Cape Province in South Africa (Smith, 1949), and from the Ceylon coast (Munro, 1955). Jones (1958) recorded its occurrence in the Arabian Sea from Minicoy Islands, Malpe in South Kanara, Colachel in South Travancore, and Mandapam Camp on the Gulf of Mannar. The occurrence of *Auxis thazard* in Ratnagiri, therefore, extends its known distribution in the Arabian Sea a little further north. It would be interesting to see if it also occurs in the Gulf of Kutch where tuna fish is reported by the Superintendent of Fisheries, Kutch, to be available.

Wade (1949), describing this species in detail, has recorded the number of gill rakers on the first gill arch as 37-43. Jones (1958), who has described *Auxis thazard* from a single specimen, records the number of gill rakers as 40. I had an opportunity to examine a number of specimens in September 1960. The gill raker counts made in 21 specimens showed the following variations :

Upper arch :	Number of rakers	..	9	10	11		
	Number of specimens	..	4	14	3		
Lower arch :	Number of rakers	..	29	30	31	32	
	Number of specimens	..	1	9	6	5	
Total rakers :	Number of rakers	..	39	40	41	42	43
	Number of specimens	..	4	6	5	5	1

The gill raker formula is, therefore, 9-11/29-32=39-43. The modal formula is 10/30=40. This range of variation in the number of gill rakers is quite within the range given by Wade (1949).

Kishinoella tonggol (Bleeker)

This species is recorded from Singapore, Java Sea, Sulu Sea, Celebes Sea, Moluccas, and from Japan to Australia ; in the Indian Ocean from the Gulf of Aden, Maldive Islands, and the coast of Ceylon (de Beaufort, 1951). Munro (1955) has also recorded this species from Ceylon. The detailed distribution of *Kishinoella tonggol* in Australian waters is given by Serventy (1942, 1956). This is the first record of occurrence of *Kishinoella tonggol* in the Arabian Sea on the west coast of India. The species can be easily identified by the extension of the pectoral fin up to the end of the first dorsal fin, the absence of the air bladder, and the finlets being yellow with grey edges. The range of variation in the gill raker count as 5-8/13-18=19-25 with a modal formula 6/16=22 is given by Serventy (1956). However, the gill raker formula given by Nakamura (1949) from Japan is 6/17=23. I have had an opportunity of examining only six specimens so far and gill raker count of all the specimens was 8/18=26. In order to work out a raker formula, more specimens will have to be observed. It is possible that a distinct race occurs at Ratnagiri, but it is premature to say this.

ACKNOWLEDGEMENTS

The author is highly indebted to Dr. C. V. Kulkarni, Director of Fisheries, Maharashtra State, Bombay, and Dr. H. G. Kewalramani, Research Officer, for suggestions and necessary corrections.

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* Not referred to in original.

Notes on Indian Caecilians

BY

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(*With two text-figures*)

Peninsular India has one of the richest caecilian faunas in the world, with no less than five recognized genera occurring there. Some of these are known in northern and north-eastern India, but they are presumably absent from the drier areas of north-western India and Pakistan.

In August 1959, I visited the Bombay Natural History Society and the Honorary Secretary, Mr. Humayun Abdulali, permitted me to examine the specimens in their collection (including one live specimen). All the forms had been referred to their proper genera. As in most museums all striped forms of *Ichthyophis* were regarded as *I. glutinosus* (Linnaeus), and the uni-coloured forms as *I. monochrous*.

At the time of my visit, I had in press 2 papers dealing with the caecilians of south-eastern Asia and the Indo-Australian Archipelago, describing certain Asiatic species, including a new genus from India.

The collection was handed over to me for study. Among other forms, it contained representatives of two species I had recently described in the two papers which were at that time in press in America. It was too late to add data from these specimens to my papers. However, since they have now been published[1] Mr. Abdulali has suggested that I publish a short article in the Journal of the Society and, to the data taken from the Bombay collection, add pertinent information and keys for other recently described Indian forms, so as to make the article more useful to students in India. This I have done.

Indotyphlus battersbyi Taylor 1960

Indotyphlus battersbyi Taylor, *Univ. Kansas Sci. Bull.* **40** : 31-36, figs. 1-4, 1960 [type locality, Khandala, Poona District, *c.* 1800 ft. (550 m.), India. Type, No. 49974, American Museum of Natural History, New York].

Three preserved specimens are in the Bombay collection : No. 1121 from Lonavla (about three miles from Khandala), Poona District, and two, Nos. 1178 and 1179, from the type locality, Poona District. I have examined also a living specimen obtained by Mr. Humayun Abdulali, from under a stone near the type locality. These specimens are presumably the only ones known, other than the type. Their variable characters are given below :

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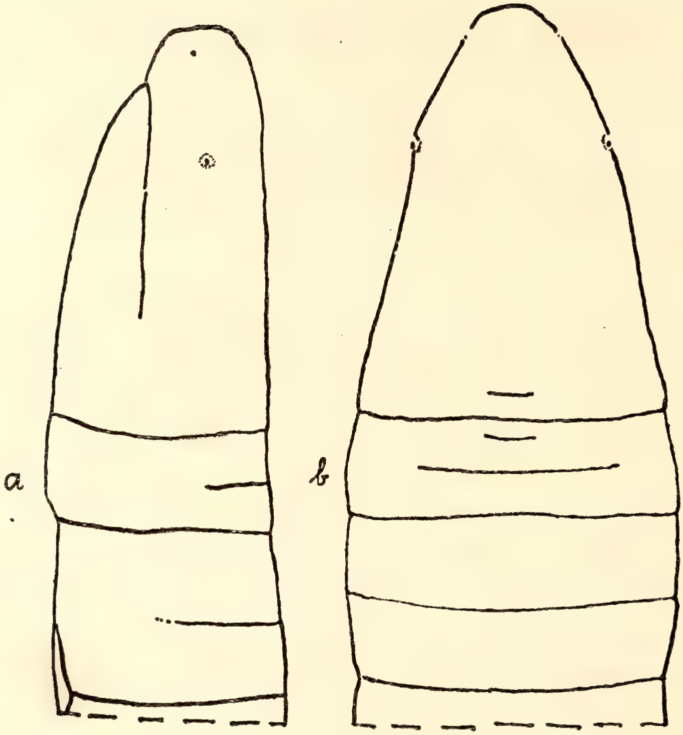
[1] On the caecilian species *Ichthyophis monochrous* and *Ichthyophis glutinosus* and related species. Taylor (1960) : *Univ. Kansas Sci. Bull.* **40** : 37-120, figs. 1-38 ; A new caecilian genus in India, *Univ. Kansas Sci. Bull.* **40** : 31-36, figs. 1-4.

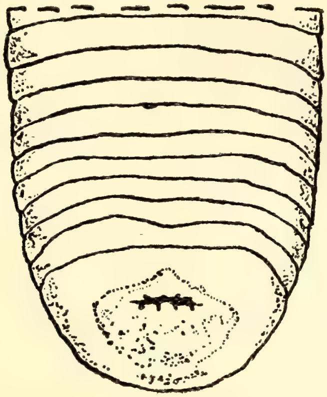


Text-fig. 1. *Indotyphlus battersbyi*
Head and anterior part of body, showing relative positions of nostril and tentacle (the eyes are not visible). *a.* side view, *b.* dorsal view. (From type, × 12)

Specimen	AMNH type 49974	BNHS 1121	BNHS 1178	BNHS 1179
Total length (in mm.)	170	200	205	220
Head length (1st groove) (in mm.)	4.2	5.4	5.5	5.5
Head width (1st groove) (in mm.)	3	3.7	3.8	3.8
Body width (in mm.)	3.7	3.95	3.8	4.1
Width in length (times)	46	50	49	53
Primary folds	139	138	133	141
Secondary folds	29	17	22	21
Total folds	168	155	155	162
*Maxillary-premaxillary teeth	9-9	12-12	11-11	14-14
*Vomeropalatine teeth	12-12	13-14	13-14	17-17
*Mandibular teeth	9-9	11-11	9-10	11-11
Splenial teeth	2-2	2-2	2-2	2-2

*Number of teeth increases somewhat with age.

On each side of the tongue, near its anterior end, there is a somewhat elevated rounded area almost surrounded by a deep groove. These areas are blackish, and in strong contrast to the light colour of the rest of the tongue. Superficially *Indotyphlus battersbyi* resembles *Gegeneophis carnosus*, a form also occurring in southern India ; however, the two species may be readily separated by examining the point of emergence of the tentacle. The position of the tentacular opening in *Indotyphlus* is directly anterior to the hidden eye, in line between the eye and nostril but much closer to the eye, whereas in *Gegeneophis* the opening is close behind the nostril and somewhat below it. The eye of *Gegeneophis* is hidden below the bones of the skull.



Text-fig. 2. *Indotyphlus battersbyi*

End of body, showing the transverse vent and the absence of a tail. (From type, × 12)

In my paper on caecilians (1960) in the key to the Indian genera I repeated Boulenger's error of stating that *Gegeneophis* lacks scales. I have since examined the type of the genus and scales are *certainly* present in the posterior part of the body where the secondary folds appear. The type of *Gegeneophis* has 114 primary folds and only six secondary, totalling 120.

In *Indotyphlus* the number of vertebrae in the type is 144, a number exceeding that of other known Asiatic caecilians. The number of vertebrae in *Gegeneophis carnosus* is not known.

The type of *Indotyphlus*, which does not bear the collector's name, may be one of the specimens collected by Charles McCann (1927) at Khandala, Poona District, and reported by him as *Ichthyophis monochrous* Boulenger, in the *J. Bombay nat. Hist. Soc.* **31** (4): 1039. McCann states : ' When at Khandala during the month of September, 1919, I secured several specimens of this batrachian. It lives under stones, during the rains, in burrows much after the fashion of the earthworm which it also resembles in its movements. At first sight it might well be mistaken for one of these creatures as its body is also coated with slime. On the removal of the stone under which it lives the animal soon begins its descent into its burrow away from the light.'

In the *Journal* **42** (1) : 64, Mr. McCann (1940) writes : ' On the 6th September 1931 while collecting frogs I discovered another specimen [of *Ichthyophis monochrous*] living under a stone on the banks of the lake behind a range of hills locally called the "Sausages". I have repeatedly hunted for this animal since its first discovery at Khandala, but without much success. The 1931 specimen measured 232 mm.'

The species is named in honour of Mr. J.C. Battersby of the British Museum of Natural History.

Uraeotyphlus malabaricus (Beddome)

Caecilia malabarica Beddome, *Madras Month. Journ. Med. Soc.* **2** : 176, 1870, (type locality, Malabar).

Uraeotyphlus malabaricus Peters, *Monatsb. Akad. Wiss. Berlin,* 1879, p. 933 ; Boulenger, Catalogue of the Batrachia Gradientia *s.* Caudata and Batrachia Apoda in the collection of the British Museum, Ed. 2, 1882, p. 92, pl. V., fig. 3.

A single specimen in the Bombay collection, No. 222, from Ootacamund, Nilgiris, south India, is referable to this species. The secondary folds cannot be distinguished from the primaries by their appearance. The secondaries begin suddenly and at once have almost the same dimensions as the primaries : that is, they do not alternate longer and shorter as is typical of certain species of the genus. The total number of folds is approximately 242 (difficult to count because of injury to the specimen). The grooves lack the light lines that are typical of certain other species of the genus. Seven folds are confined to the tail. Scales are absent or rare in the anterior third of the body ; they form an incomplete row at the 64th fold, and extend practically around the body at the 100th fold. Posteriorly there are two complete rows in each fold and occasionally part of another row may be present.

The teeth have the following formula :

Maxillary-premaxillary, 16-17 ; vomeropalatine, 17-19 ; mandibular, 19-20 ; splenial, 8-9.

The total body length is 157 mm. The body width, 7.6 mm.

Ichthyophis subterrestris Taylor 1960

Ichthyophis subterrestris Taylor, *Univ. Kansas Sci. Bull.* **40** : 65-67, 1960 (type locality, Kottayam, Travancore, India. Type, No. 73927 "Travancore-Cochin", Chicago Nat. Hist. Museum.)

Two specimens in the collection of the Bombay Natural History Society belong to this species :

No. 217, from Injiparai Estate, Anamalai Hills, agrees well with the type in most characters. Only nine transverse folds can be counted on the injured tail : the expected number is 16 to 18. The count of 355 for the folds is probably low, and should be 364, if allowance is made for the missing caudal folds. The tooth formula is :

Maxillary-premaxillary, 23-23 ; vomeropalatine, 23-23 ; mandibular, 20-20 ; splenial, 13-13.

No. 223, from Alibag, Kolaba Dist., Bombay, is a small specimen, probably recently transformed, that has been broken into several pieces. No attempt has been made to count the folds.

This species is seemingly distinguished from other species of the Indian peninsula by the following combination of characters : the shape and position of the tentacular opening ; the elongate tail with the high number of transverse folds ; the tail length being contained in total length only 22.2 times ; and the enlarged mandibular teeth. The colour of the venter (dark) separates it from *peninsularis* and the body proportions of the two species seem to be somewhat different.

Ichthyophis peninsularis Taylor 1960

Ichthyophis peninsularis Taylor, *Univ. Kansas Sci. Bull.* **40** : 61-65, figs. 9, 10, 11, 1960 (type locality, Malabar, India. Type, B.M. No. 82, 12-12-6.)

Diagnosis : A large species with a broad, relatively short head ; the eye invisible covered by a raised circular white spot ; the tentacle nearer the eye-spot than to nostril ; body width in length 22 times ; tail long, its length in total length nearly 22 times ; transverse folds 363-366 ; folds on tail, 18 ; vertebrae, 116. Splenial teeth 3-4 on each side ; mandibular teeth large. Ventral surface very light, probably yellow or cream colour in life. A well-defined cream spot at vent.

The increased number of vertebrae, the coloration of the venter, and reduction in size of the vomeropalatine teeth seem to separate this species from other Indian species. Other differences are evident on a comparison of the type descriptions.

Ichthyophis malabarensis Taylor 1960

Ichthyophis malabarensis Taylor, *Univ. Kansas Sci. Bull.* **40** : 80-84, figs. 20, 21, 22, 1960 (type locality, Maduvangard, Travancore, India. Type B.M. 94. 3. 15. 3).

Diagnosis : Large, reaching a length of approximately half a metre, and the largest Oriental species. Tail proportionally long, its length in total length 23.5 times ; transverse primary and secondary folds 360, 14 confined to tail; vertebrae 111; splenial teeth, 10-10; tentacular opening near edge of lip, closer to eye than to nostril. Scales four to five in each fold except the most anterior ones.

Remarks : It would appear that this species is rare in its range or that it burrows to a considerable distance below the surface of the earth. A creature so conspicuous would otherwise be better known. Despite the fact that it is the largest caecilian reported from Asia, it has a relatively low number of vertebrae (111). The number of folds on the tail is 14, a lower number than occurs in certain other Indian forms.

The specimen is a female containing many large eggs (5.6 mm. in diameter), the number estimated to be more than 60.

Ichthyophis bombayensis Taylor 1960

Ichthyophis bombayensis Taylor, *Univ. Kansas Sci. Bull.* **40** : 67-69, fig. 12, 1960 (type locality, Waghai Surat, Bombay, India. Type, B.M. No. 86. 6. 11. 1.)

Diagnosis : A large species (390 mm.) having 386 transverse folds, 14 confined to tail; splenial teeth, 9-9; body width in length, 26 times; vertebrae, 121; colour in preservative, dark brown above, somewhat lighter brown below; tail relatively long contained in total length about 25 times; tongue tending to cover the splenial teeth; mandibular teeth much larger than maxillary-premaxillary series; vomeropalatine teeth relatively small, scarcely extending through the thick gums.

Remarks : The increased number of vertebrae, the coloration, the enlarged mandibular teeth and the reduction of the size of the vomeropalatine teeth seem to separate this from southern Indian forms. The specimen is a male.

Ichthyophis sikkimensis Taylor 1960

Ichthyophis sikkimensis Taylor, *Univ. Kansas Sci. Bull.* **40** : 91-95, figs. 28-30, 1960 (type locality, Darjeeling, India. Type, No. 64216, Calif. Acad. Sciences.)

Diagnosis : A medium-sized species, characterized by 106-108 vertebrae; primary and secondary transverse folds 276-292; series of splenial teeth (9-9 or 10-10); tail short, contained approximately 50 times in total length, bearing five or six folds from front of vent; tentacle near lip, closer to eye than to nostril. Scales sparse or absent in anterior half of body; two to four rows in each fold posteriorly.

Variation : No. 2685* has the pharyngeal region considerably thickened and widened. The eye area is milky white, the pupil not visible. The tongue seemingly is not completely developed. It is very short, covering the splenial teeth, and its posterior limit is a ridge curving forward. This specimen agrees reasonably well with the others in tooth counts, vertebrae, and transverse folds. It is, judging from the tongue, a recently transformed specimen that has not attained all the adult characters.

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*Museum of Comparative Zoology, Harvard.

No. 2574*, the other Sikkim specimen, is very light, almost white, on the venter and nearly white on the chin. I cannot be certain that this specimen has not been faded somewhat by light. The two Darjeeling specimens vary but little from each other. Nothing is known of the exact habitats except that No. 2685 comes from the Rungeet Valley.

Ichthyophis tricolor Annandale 1909

Ichthyophis glutinosus tricolor Annandale, *Rec. Ind. Mus.* **3** : 286, 1909 (type locality, Maddathori, India) ; ibid **9** (4) (19) : 346-347, 1915 (Western Ghats, Cochin).

Ichthyophis tricolor Taylor, *Univ. Kansas Sci. Bull.* **40** : 113-114, 1960.

Since I proposed the revival of the name *tricolor* for a species of *Ichthyophis* in India, I have been able to examine certain specimens of the species in the collection of the British Museum. These specimens agree with the extremely brief colour description by Annandale, who saw three specimens. He mentions one that measured 280 mm. in length, but gives no other anatomical data. Annandale regarded *tricolor* as a variety of *glutinosus*, but it is not known what form was called *glutinosus* by him.

The two British Museum specimens are No. 93. 4. 18. 26 from Peermed, Travancore, and No. 82. 12. 12. 5 from the ' Nilgiris'. The second specimen was presumably taken in the same general locality as four specimens of a different species that lacks the ventral white stripe. The counts of the teeth of the two specimens are respectively :

Maxillary-premaxillary, 19-19, 20-21 ; vomeropalatine, 23-24, 28-29 ; mandibular, 15-15, 19-19 ; splenial, 24-23, 25-26.

The mandibular teeth are the largest, while the splenials are relatively very small. The tentacle is nearly equidistant from the eye and the nostril (2.3 mm. and 2.45 mm. respectively). The number of transverse folds is low, 245 for the male, 275 for the female. The lateral yellow stripe extends from near the tip of the snout to the tip of the tail, dividing at the angle of the mouth. A broad white (or yellow) midventral stripe is separated from the yellow lateral stripe by a stripe of brownish lavender, with a rather indefinite edge. The jaw and part of the chin are cream with a slightly pigmented area near the centre of the chin.

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*Berlin Museum.

Scales are present throughout the body, the first folds having three rows of rather large scales widened transversely, the posterior folds having seven rows in each fold.

Variable characters of *Ichthyophis tricolor* Annandale :

Specimen	BM 93.4.18.26	BM 82.12.12.5
Sex	Male	Female
Total length (in mm.)	226	296
Tail (in mm.)	4	4.85
Body width (in mm.)	12.8	12.8
Head width (1st groove) (in mm.)	8.1	9
Distance between eyes (in mm.)	5	5.5
Eye to tip of snout (in mm.)	4.65	5.6
Head length (to 1st groove) (in mm.)	11	13
Head length (to 3rd groove) (in mm.)	21	19.8
Eye to tentacle (in mm.)	2.3	2.5
Tentacle to nostril (in mm.)	2.5	2.6
Transverse folds	245	275

The male specimen came from an elevation of 3300 ft. (1005 m.).

Ichthyophis beddomii Peters 1879

Ichthyophis beddomii Peters, *Monatsb. Akad. Wiss. Berlin,* 1879, p. 931, pl.—figs. 1-3 (type locality, Nilgiris, India) ; Taylor, *Univ. Kansas Sci. Bull.* **40** : 113, 1960.

Ichthyophis glutinosus (part.) Boulenger, Catalogue of the Batrachia Gradientia *s*. Caudata and Batrachia Apoda in the collection of the British Museum, 1882, p. 90.

I have referred three specimens in the collection to *Ichthyophis beddomii* Peters. These are: Nos. 219 and 220 from Ootacamund, Nilgiri Hills, southern India, and No. 527 from near Gersoppa Falls, North Kanara, India (the last was taken on a laterite path by day, and was said ' to progress by a series of ripples reminiscent of a millipede ').

Peters distinguished this species by the following characters : tentacle near lip, nearly equidistant from the eye and the nostril ; the head small, pointed or acuminate; a lateral stripe on the body, and low number of transverse folds on the body (240 in the type).

The type of this species, formerly No. 5545 in the Berlin Museum, was not to be found on my recent visit there, and Dr. Heinz Wermuth, the Curator, believed that the specimen had been lost.

It will be seen from the following table that the type has fewer transverse folds and the body is narrower in proportion to length than the other specimens listed.

Specimen	BNHS 220	BNHS 219	BNHS 527	Type
Total length (in mm.)	265	257	185	225
Head width (in mm.)	7	—	—	—
Head length (in mm.)	9.3	—	11	—
Body width (in mm.)	16	15	11	10
Width in length (times)	16.5	17	16.5	22.5
Transverse folds, total	293	284	281	240
Transverse folds on tail	5	5	—	5
Maxillary-premaxillary teeth	23-23	23-25	24-25	—
Vomeropalatine teeth	28-27	27-27	23-24	—
Mandibular teeth	25-26	22-22	24-24	—
Splenial teeth	26-25	24-25	25-26	—

Moreover the count of folds (240) is lower than in 15 other specimens of the species I have been able to examine, most of which are from the Nilgiri Hills. Three specimens in the British Museum from ‘ Wynaad, Nilgiris, India ’ have counts of 255, 263, and 273. The number of maxillary teeth in these specimens is a little less than in the specimens listed above. Tail length in total length about 30 times.

In all, the lateral yellow stripe is widened anteriorly so that there is a suggestion of two yellow triangles joined to the lateral stripes on the throat. A fork from the stripe beginning at the mouth-angle extends anteriorly to the tip of the lower jaw.

Usually one or two rows of scales are present in the folds on the anterior part of the body (beginning on the first or second fold). Posteriorly there are usually four rows in each fold.

It is impossible to state now whether this variation in the number of folds is a result of sex, elevation, or individual variation.

KEY TO GENERA OF GYMNOPHIONA IN INDIA

1. Tentacle closer to eye than to nostril (or tip of snout) or equal 2

Tentacle closer to tip of snout than to eye.. 3

2. Anal opening transverse; the tentacle cone-shaped, on a level with a line between eye and nostril; no tail; 144 vertebrae; splenial teeth present.. .. .. *Indotyphlus*

Anal opening longitudinal; tentacle near edge of lip below level of a line between eye and nostril; tail present; vertebrae not over 125; splenial teeth present or absent .. .. *Ichthyophis*

3. Squamosal and parietal bones of skull separated by a diastema. Tentacle flaplike situated almost directly below nostril near mouth; orbit circular enclosed; tail region wider than body .. .. .. *Uraeotyphlus*

Squamosal and parietal bones forming a common suture 4

4. A single row of teeth in lower jaw. No splenials .. .. *Gegeneophis*

Two rows of teeth in lower jaw; eye covered over by bone; tentacle conical somewhat behind nostril but below its lower level .. .. *Herpele*

KEY TO INDIAN SPECIES OF *Ichthyophis*

1. A lateral stripe of cream or yellow on side of body from head to tail; splenial teeth usually more than 20 on each side 2

No lateral stripe of cream or yellow on side of body; usually less than 20 splenial teeth on each side 4

2. Venter uniform brown lavender, to plumbeous; position of tentacle variable 3

Venter with a broad white or yellow mid-ventral stripe; tentacle near lip and nearly equidistant from eye and nostril; transverse folds 245-275; tail length in total length 56.5 times ♂, 60 times ♀ .. *tricolor*

3. Tentacle nearly equidistant from eye and nostril; lateral yellow stripe widens in region of throat; fewer transverse folds (240-293) .. *beddomii*

Tentacle near lip, much closer to eye than to nostril; higher count of ventral folds (300-400) lateral stripe not widening under throat .. .. ? *glutinosus* vars.

4. Number of folds on tail less than ten; body folds less than 300; tail length in total length about 50 times; splenial teeth 9 or 10 on each side; vertebrae, 106, 108; scales sparse or absent anteriorly, two to four rows in posterior folds .. .. *sikkimensis*

Number of transverse folds on tail more than ten; on body usually more than 300; tail length in total length less than 30 times 5

5. Splenial teeth four or less on each side; 18 transverse folds on tail; vertebrae 116; body width in body length, 20-22 times; venter light coloured (perhaps cream or yellowish in life); total length, 330 mm. .. *peninsularis*

Splenial teeth five or more on each side in full-grown animals, transverse folds 356-386; tail folds, 14-18 6

6. Number of mandibular teeth high (28-28); tail in total length about 23.5 times; body width in body length 27 times; vertebrae 111; scales in anterior folds small sparse; posteriorly four or five rows in each fold; venter light (perhaps cream or yellow in life); total length 494 mm. .. .. *malabarensis*

Number of mandibular teeth reduced (17-20) 7

7. Mandibular teeth, 20-20; splenial, 9-9; transverse folds 386; 14 folds confined to tail; width of body in total length 26 times; tail length in total length 25.6; venter brown to lavender brown; one row of scales in anterior folds, three in posterior; total length, 390 mm. .. *bombayensis*

Mandibular teeth very large, 17-17; splenial, 10-10; transverse folds 356-364, 18 confined to tail; body width in total length 21 times; venter dark lavender brown; two rows of scales in anterior folds; four or five in posterior rows; total length 295 mm. .. .. *subterrestris*

A study is in progress of the forms of Indian caecilians hitherto confused with *Ichthyophis glutinosus*. The provenance of the type (still in existence) has not been yet satisfactorily determined, and these forms are not treated here.

Amphipnous indicus, a new synbranchoid eel from India, with a Redefinition of the genus and a Synopsis to the species of *Amphipnous* Müller[1]

BY

E. G. SILAS AND E. DAWSON
Central Marine Fisheries Research Institute, Mandapam Camp

(*With two text-figures and two plates*)

INTRODUCTION

On 28 July 1957 while collecting fish from a stream passing through Krishnagiri National Park, Bombay, one of us (E. G. Silas) came across a tiny eel-like fish 84 mm. in length. Subsequently a second specimen was obtained just above the main falls at Kanheri Caves about three miles further up. During the last week of September and early in October of the same year, it was once again possible, assisted by a party from the Natural History Section of the Prince of Wales Museum of Western India, Bombay, to collect several specimens of similar eel-like fishes from a streamlet passing through Robbers' Cave, Mahableshwar, Satara District, and one specimen from an adjacent stream at Mahableshwar. A note on the fishes collected on an earlier occasion from the Robbers' Cave together with some ecological observations has appeared elsewhere (Silas, 1953).

A close examination showed that all these eel-like fishes collected at Borivli (elevation between 30 and 75 metres above m.s.l.), and Mahableshwar (elevation about 1400 metres) are identical, belonging to a hitherto undescribed species of the synbranchoid family Amphipnoidae, known thus far from only two species, *A. cuchia* (Hamilton), said to be the most highly evolved air-breathing fish in India, and *A. fossorius* Nair. The new species is designated here as

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[1] Published with the permission of the Director, Central Marine Fisheries Research Institute, Mandapam Camp.

Amphipnous indicus sp. nov., based on its systematic description given below. The anatomical details etc. will be dealt with separately.

Amphipnous indicus sp. nov.

Material:

Holotype: 1 specimen 412 mm. in total length.

Type locality: Robbers' Cave, Mahableshwar, Satara District, Maharashtra State, India.

Paratypes: 43 specimens from Robbers' Cave, Mahableshwar; 1 specimen from Dhobi Falls, Mahableshwar; 1 specimen from Davri R., Krishnagiri National Park, Borivli, Bombay; 1 specimen from above Kanheri Falls, Kanheri Caves, Bombay.

The type material will be deposited in the research collection of the Bombay Natural History Society.

Diagnosis:

Body elongate, eel-like, head relatively short, snout bluntly rounded, and occipital region dome-shaped and muscular; scales present in irregular rows on tail and in a narrow streak along dorsum in posterior part of trunk and occasionally in a small isolated patch midventrally in front of vent; palatine teeth anteriorly in three or four rows; branchiostegals five; gills greatly reduced to highly vascularised plate-like structures present on third and fourth branchial arches; suprabranchial accessory respiratory chamber well developed; preanal vertebrae 93 to 99.

DESCRIPTION

Body proportions:

In the following paragraph the body proportions are given in thousandths of the total length as follows. First that of the holotype is given followed in parenthesis by the range and mean for all the specimens examined. For additional details reference may be made to Table IV.

Head 76 (65-84 : 73); eye 5 (4-9 : 5); snout 21 (14-23 : 19); interorbital distance 19 (9-21 : 16); tip of snout to posterior nostril 19 (13-20 : 17); isthmus between gill openings 16 (12-21 : 16); width of gill opening 6 (2-9 : 6); gape of mouth 27 (16-27 : 22); snout to vent 794 (770-830 : 798); greatest height of body 36 (25-41 : 34); width of body 31 (22-35 : 27); snout to occiput 70 (57-78 : 68);

height at occiput 30 (26-38 : 31); distance between anterior nostrils 9 (5-14 : 10); distance between posterior nostrils 12 (7-15 : 12); snout to posterior nostril 19 (13-20 : 17); greatest width of upper lip 9 (4-11 : 8); width of lower lip 4 (3-7 : 5); height of head 38 (25-42 : 35); depth of body at vent 28 (18-32 : 27); depth of body midway between vent and caudal end 22 (16-32 : 24); width of body at vent 20 (16-25 : 21); end of maxilla to tip of snout 40 (26-45 : 37); end of maxilla to tip of lower jaw 34 (21-38 : 31); and length of preanal scaly patch along dorsum 252 (110-392 : 226) in total length.

Head:

The head is conspicuous from the rest of the body by the dome-shaped muscular occipital region and the bluntly rounded snout. A profuse secretion of mucus, mostly from the anterior part of the body was noticeable soon after the animals were caught and when preserved in formalin this formed into a thick opaque covering all over the body, especially on the head and scaleless part of the trunk. When the mucus layer is cleared, the glandular skin with the pitted surface, especially on the head and nape region is discernible (Plate I, figs. 10 & 11).

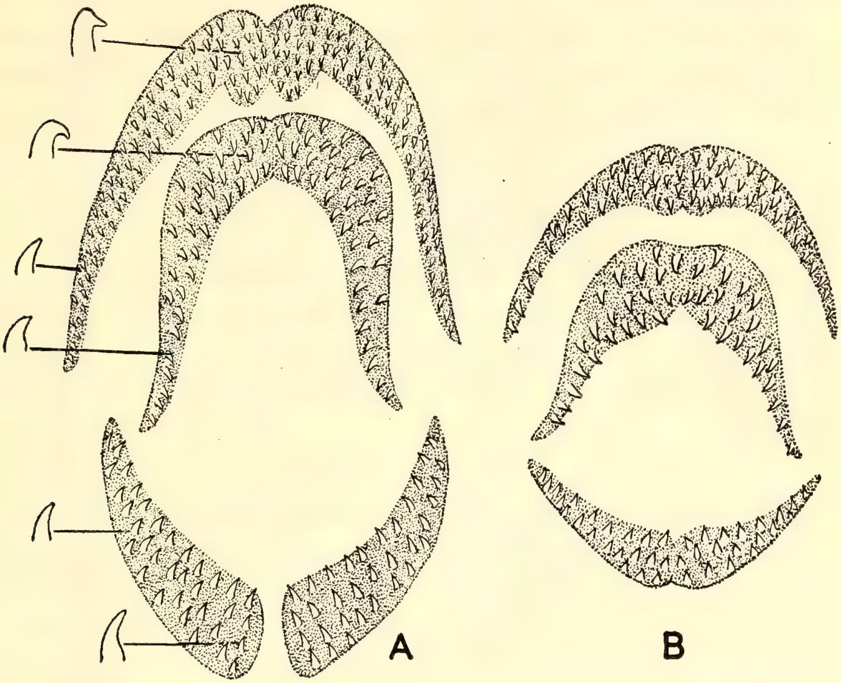
The eyes are greatly reduced and covered by skin. Usually, in preserved specimens the opaque mucus layer completely obliterates the eyes from view.

Part of the snout and upper jaw overhangs the ventrally positioned mouth. The upper lip is thick and overlaps part of the lower lip. Towards the extremity on either side of the symphysis the anterior nostrils appear as two holes. The post-labial groove is not continuous, being interrupted anteriorly at the symphysis of the lower jaw.

Dentition:

While the general pattern is the same both in the young and adults of *A. indicus*, there is a tendency in the larger specimens for an increase in the number of teeth on the maxillary, palatine, and mandibular bands (Text-fig. 1). In a specimen 425 mm. long the palatine band shows four rows of teeth anteriorly which progressively decrease to a single row in the posterior third of the band. The maxillary band has 5 to 6 rows of teeth near the symphysis, but laterally it shows three rows becoming uniserial at the posterior end. When the mouth is closed, in the larger specimens part of the maxillary band of teeth is seen exposed. The mandibular teeth are arranged in three or four rows at the symphysis. The shape of the teeth at different parts of the bands are indicated in Text-fig. 1.

The pattern of the dentition is another important feature distinguishing the new species from its congeners. In *A. cuchia* the palatine and mandibular teeth are uniserial. In the case of *A. fossorius* the maxillary teeth are arranged in two or three rows at the anterior end, but uniserial in the posterior half and the palatine teeth are biserial anteriorly and uniserial posteriorly; further, the teeth in *A. fossorius* are more pointed and distinctly directed backwards than in *A. indicus*.



Text-fig. 1. Dentition of *Amphipnous indicus* sp. nov.
A. paratype 425 mm. long, and B. paratype 127 mm. long.

Caudal region:

The dorsal and anal 'fin folds' or ridges vary with age, being more conspicuous in the young. In the latter, the dorsal ridge commences about 0.25 length of head behind level of vent while it can be made out only in the posterior third of the post-anal distance in the adults. The anal ridge commences almost midway between the vent and the end of the caudal in the young, while in the adults it is seen only in the last fourth of the length of the post-anal distance. In *A. cuchia* the dorsal 'fin fold' is said to commence slightly ahead of a vertical line above the vent, while in *A. fossorius* the condition is more or less as in *A. indicus*, but the anal fold in *A. fossorius* commences from the mid post-anal distance. The caudal tip in *A. indicus* is bluntly rounded.

Scales:

The scales are present in the post-anal part of the body. Anterior to and above the vent they occur as a narrow band along the dorsum extending to some distance in the front, but not surpassing the mid-point of total length. The sides above the vent and slightly behind it are devoid of scales (Pl. I, figs. 4 & 14, and Pl. II, figs. B & C). In a few specimens a small scaly patch is present in front of the vent midventrally.

Although the scales are not arranged in regular longitudinal rows, they are nevertheless countable. Where they completely encircle the body behind the vent there are on the average about 52 scales as shown by the frequency of their occurrence in 40 specimens detailed in Table I.

TABLE I

Frequency of occurrence of scales round body behind vent in *A. indicus* sp. nov.

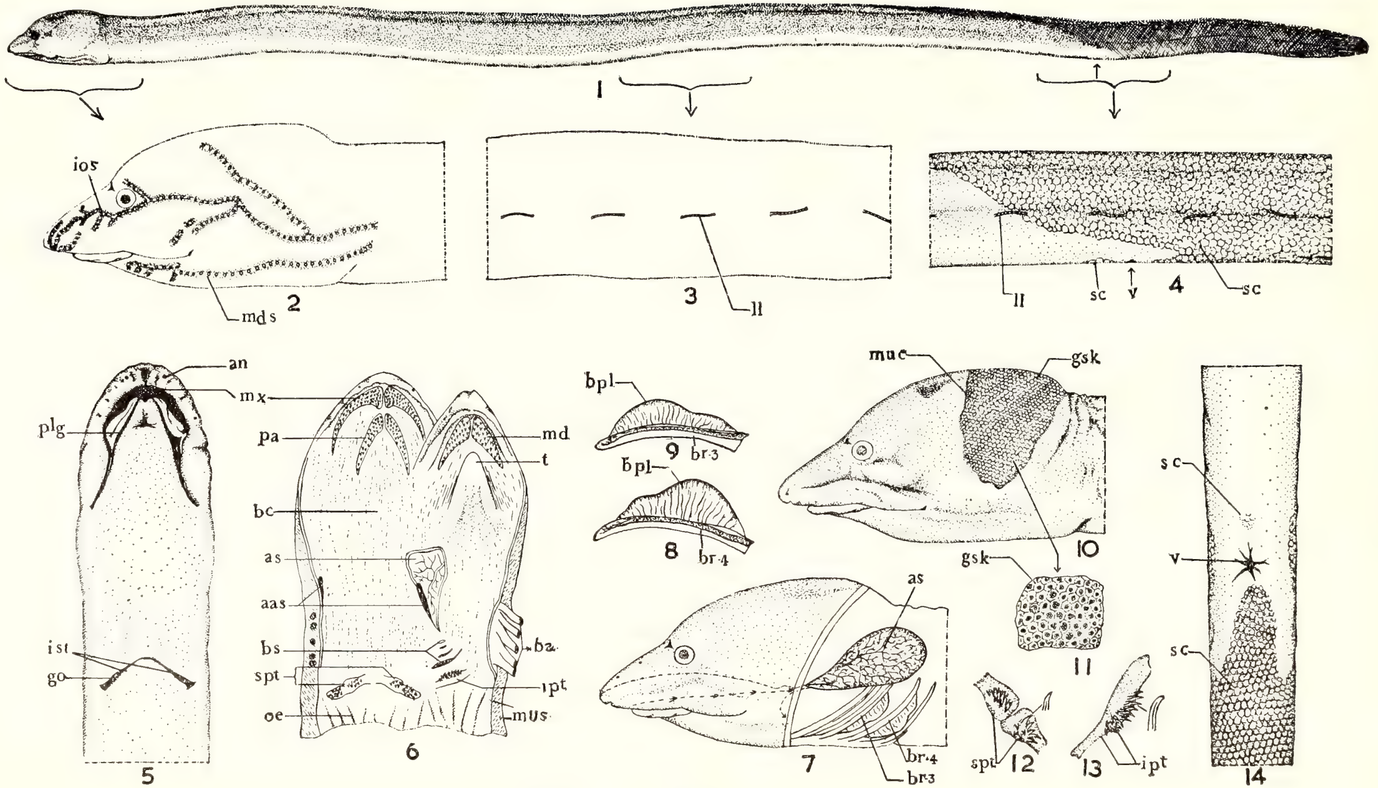
No. of scales	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65
No. of specimens	—	1	3	3	3	3	3	2	3	7	7	3	1	1	—	—	1	—	—	—	—

The scales are relatively much smaller when compared to those of *A. fossorius*. A typical scale from the side of the tail of a specimen 372 mm. long shows the basal nucleus extending to one-third the length of the scale. The radii are complete, there being 8 apically and 12 or 13 laterally on each side. The circuli are widely spaced apically, numbering 12 in this region. Laterally they are placed more close together and many terminate at the sides of the nuclear area, so much so that only 3 closely placed basal circuli are seen. Variations from this general pattern are seen in scales from different parts of the body and these will be dealt with elsewhere along with a comparative account of the scales of all the three species.

Lateral canal system:

In *A. indicus*, the lateral canal system is well developed and is clearly discernible even in the juveniles. The typical pattern as seen in the larger specimens is shown in Pl. I, figs. 2, 3, & 4. The canal

PLATE I


1
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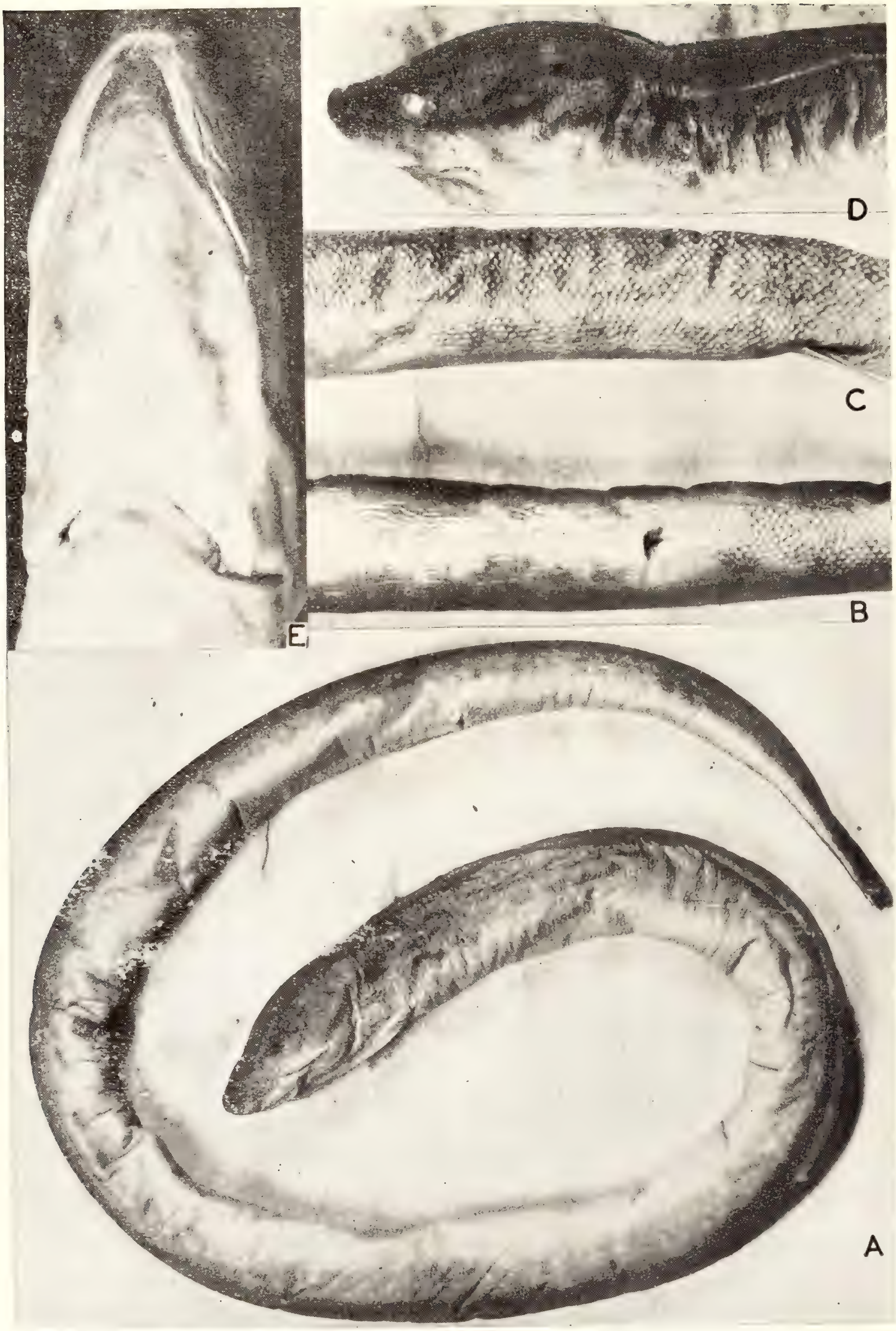
Amphipnous indicus sp. nova
For explanations see p. 378.



Amphipnous indica sp. nova
For explanations see p. 378.

system on the body appears discontinuous along the mid-lateral part of the body where it is present as short linear streaks each having a number of open pores. The lateral canal system is generally not visible unless the mucus over the body is cleared away.

The nature of the lateral canal system is not known in the case of *A. cuchia* and *A. fossorius*. However, the condition seen in the head region of *A. indicus* differs considerably from that of an allied synbranchoid fish *Monopterus javanensis* Lacépède as described by Yih (1948). The mandibular canal is present in both, but *A. indicus* shows a distinct infraorbital canal (Pl. I, fig. 2), which is absent in *M. javanensis*. The latter instead has the supraorbital canal well developed. It is likely that the nature of the lateral canal system may vary in the different species of the genus *Amphipnous*.

Vertebrae:

X-ray photographs of 32 specimens were taken for vertebral counts. From these, the pre-anal vertebrae could be clearly counted, while those towards the end of the tail were rather indistinct. However, two specimens cleared and stained with alazarin showed 95 and 99 pre-anal and 42 caudal vertebrae respectively.

TABLE II

Frequency of occurrence of pre-anal vertebrae in *A. indicus* sp. nov.

No. of pre-anal vertebrae	90	91	92	93	94	95	96	97	98	99	100
No. of specimens	—	—	—	3	8	10	11	1	—	1	—

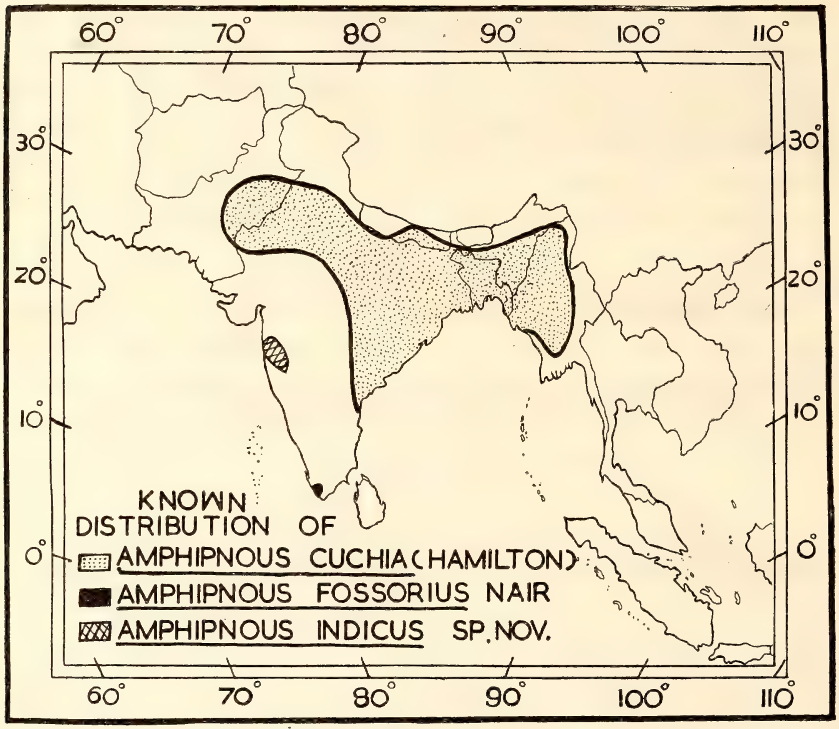
The number of pre-anal vertebrae thus range from 93 to 99 (average about 95) while the total number of vertebrae for the species is about 137 to 144.

The number of vertebrae differ in the three species of *Amphipnous* as shown in Table III.

TABLE III

Characters	*A. indicus* sp. nov.	*A. cuchia* (Ham.) (after Günther, 1870)	*A. fossorius* Nair (after Nair, 1951)
No. of pre-anal vertebrae	93-99	106	73
No. of caudal vertebrae	42-45	65	53-56
Total No. of vertebrae	137-144	171	126-129

In this connection it is interesting to note that Nair (1951) found the pre-anal vertebrae in *A. fossorius* to be constant (73), while the caudal vertebrae were found to vary in number. The range for *A. cuchia* is not known, but the figures given indicate a much higher count for that species. The vertebral counts in the three species also indicate another interesting trend of an increase from the southern to the northern latitudes as seen in the lowest counts in *A. fossorius* from the southernmost part of India to the highest counts in *A. cuchia* in the northernmost parts of India. Text-fig. 2 shows the natural distribution of the three species.


60°
70°
80°
90°
100°
110°
30°
20°
10°
0°
KNOWN DISTRIBUTION OF
▨ AMPHIPNOUS CUCHIA (HAMILTON)
■ AMPHIPNOUS FOSSORIUS NAIR
▩ AMPHIPNOUS INDICUS SP. NOV.

Text-fig. 2. Map showing the distribution of species of the genus *Amphipnous* Müller

Branchial region:

The gill filaments of the third and fourth branchial arches are reduced and fused to form plate-like organs which are highly vascular. The first two branchial arches are placed close together, so much so that, instead of a branchial slit there is only a shallow blind pocket indicating the position in the wall of the bucco-pharyngeal cavity. Behind this are three narrow branchial slits, the posteriormost one being the broadest (Pl. I, fig. 6). The gill opening on either side is narrow and is separated by a wide isthmus. The gill membranes unite with each other to form a slight ridge below the isthmus, but the latter can be distinctly made out.

The walls of the accessory air chamber are also highly vascular but, unlike *A. cuchia* where the accessory air chamber is much elongate and shown by Das (1927) as surpassing posteriorly a line above the gill opening, in *A. indicus* the chamber is relatively broader and falls short of a vertical above the gill opening. All three species show differences in the branchial region which will be dealt with elsewhere.

Sex:

There appears to be no noticeable difference externally between the two sexes. In some of the larger males the testicular lobes extend forwards to just below the posterior end of the liver. In mature females, the single-lobed ovary also extends to below the liver. Two of the specimens dissected showed fully gravid ovaries, while a few others showed spent ovaries.

Colour:

Almost all specimens when caught fresh were reddish or flesh-coloured. On preservation, with the mucus layer removed, dorsal surface is generally greyish or dusky and ventral side dirty white.

Weight and size:

The maximum weight of 72.1 gm. was noted for a specimen measuring 447 mm. in total length. The maximum length of a specimen in the collection is 480 mm.

Altitudinal distribution:

The collection of *A. indicus* from about 1400 metres above m.s.l., at Mahableshwar, is interesting, and shows the distribution of the species as occurring from just above sea-level to the colder waters of the hill streams of the Western Ghats of Bombay. The smallest specimen from Mahableshwar measures 82 mm. and this combined with the condition of the ripe ovaries of two of the specimens examined and the spent ovaries of a few others suggests the possibility of the fish breeding inside the cave or in the marshy areas in the vicinity of Robbers' Cave. That the fish could be a resident in the cooler waters at that altitude is also suggested by the recent discovery of its congener, *A. cuchia,* from the Kathmandu Valley, Nepal (DeWitt, 1960). In view of this, it will not be surprising if *A. fossorius*, at present known only from the low-lying areas near Trivandrum, is also found to occur in marshy places along the courses of hill streams in the Western Ghats of Kerala. In any case, the spatial distribution of *A. indicus* and *A. cuchia* shows their adaptability to relatively cooler waters also.

TABLE IV

DETAILS OF BODY PROPORTIONS

(No. of specimens followed by range in thousandths of total length: the averages are given in parentheses)

Species	*A. indicus* sp. nov.					*A. fossorius* Nair
Total length	0 - 100 mm.	101 - 200 mm.	201 - 300 mm.	301 - 400 mm.	401 - 500 mm.	192 mm.
Head length	5 : 73-80 (76.5)	3 : 66-71 (68.5)	3 : 65-69 (66.6)	15 : 66-78 (72.8)	20 : 74-84 (78.4)	83
Diameter of eye	5 : 5-9 (6.8)	3 : 5-8 (7.0)	3 : 4-5 (4.6)	15 : 4-6 (4.8)	20 : 4-6 (5.0)	6
Length of snout	5 : 16-22 (18.8)	3 : 16-18 (17.0)	3 : 14-17 (15.3)	15 : 16-22 (19.3)	19 : 18-23 (20.4)	20
Height of body	5 : 28-33 (29.6)	3 : 25-37 (30.3)	3 : 31-34 (32.3)	15 : 31-40 (35.3)	20 : 30-41 (35.4)	29
Width of body	5 : 22-30 (25.2)	3 : 25-31 (28.0)	3 : 24-29 (27.0)	15 : 25-35 (27.8)	20 : 24-35 (29.0)	23
Height of head	4 : 26-29 (28.0)	3 : 25-31 (27.6)	3 : 30-34 (32.0)	15 : 33-39 (35.7)	20 : 33-42 (37.8)	33
Depth at vent	4 : 23-29 (26.2)	2 : 24-28 (26.0)	3 : 28 (28)	15 : 25-32 (28.3)	20 : 18-32 (26.4)	19
Angle of mouth to tip of snout	4 : 26-39 (33.0)	2 : 31-33 (32.0)	3 : 30-34 (32.6)	15 : 31-40 (36.1)	19 : 35-45 (41.6)	42
Dist. bet. upper angles of gill openings	5 : 18-24 (20.2)	2 : 20 (20.0)	3 : 20-21 (20.6)	15 : 19-21 (21.4)	20 : 18-23 (21.7)	13
Snout to vent	5 : 762-791 (776.2)	3 : 734-784 (768.3)	3 : 796-803 (800.3)	14 : 775-814 (811.1)	20 : 784-830 (810.0)	779
Length of pre-anal scaly patch	4 : 110-167 (148.5)	—	3 : 258-341 (286.1)	15 : 137-311 (244.4)	20 : 144-290 (208.5)	*167?

* In this specimen examined, the scales are absent in the anterior part of the trunk.

Redefinition of the Genus *Amphipnous* Müller 1839

The last definition of the genus *Amphipnous* Müller given by Day (1878) reads as follows:

'Branchiostegals six. Gill membranes almost entirely grown to the isthmus, and having a single transverse opening. Three branchial arches with the laminae rudimentary, divided by narrow slits. A respiratory air sac exists on the neck behind the head communicating with the gill cavity. Palatine teeth in a single well-developed row. Scales present and arranged in longitudinal rows.'

With the discovery of *A. fossorius* and *A. indicus* from peninsular India, a redefinition of the genus is necessary and this is given below:

Genus **Amphipnous** Müller

Amphipnous Müller, 1839, *Adh. Akad. Wiss. Berlin*, p. 244 (Orthotype: *Unibranchapertura cuchia* Hamilton).

Pneumobranchus McClelland, 1844, *Calcutta Journ. Nat. Hist.* 5 : 192 [Logotype : *P. striatus* McClelland = *A. cuchia* (Hamilton)].

Branchiostegals five or six; body elongate, cylindrical anteriorly and tail compressed laterally; body partly or wholly covered with small cycloid scales; posterior nostrils placed interorbitally; anterior nostrils placed near end of snout in upper lip; fins totally absent, but short dorsal and anal rayless folds of skin present on tail, confluent at tip; suprabranchial accessory respiratory chamber present on either side; gills greatly reduced and fused to form highly vascular plate-like structures on two or three branchial arches; two or three branchial slits leading from buccopharyngeal cavity to branchial chamber; a pair of gill openings partly or well concealed by the fold of the united gill membranes; teeth uniserial or multiserial on jaws and palate; vertebrae 121 to 171, pre-anal vertebrae numbering 73 to 106.

The genus is distributed along parts of India, Pakistan, Nepal, and Burma.

Synopsis to the Species of the Genus *AMPHIPNOUS* Müller

1. Palatine and mandibular teeth in two or more rows; vertebrae 126 to 144, pre-anal vertebrae being 73 to 99 3
2. Palatine and mandibular teeth uniserial; vertebrae about 171, pre-anal vertebrae 106 (longitudinally arranged scales present throughout body; branchiostegals 6) .. .. *Amphipnous cuchia* (Hamilton)

3. Snout pointed ; skin of branchial region of ventral side of head drawn out into longitudinal folds ; teeth on palate anteriorly biserial ; body covered with longitudinal rows of minute scales ; branchiostegals 6 ; pre-anal vertebrae 73 .. .. *Amphipnous fossorius* Nair

4. Snout bluntly rounded ; skin of branchial region of ventral side of head not drawn into longitudinal folds ; teeth on palate anteriorly tri- or quadriserial ; scales present only on posterior half of body along dorsum in a narrow streak and on sides of tail and a small scaly patch may or may not be present midventrally in front of vent ; branchiostegals 5 ; pre-anal vertebrae 93 to 99. .. .. .. *Amphipnous indicus* sp. nov.

SYNONYMY AND NOTES ON THE SPECIES

Amphipnous cuchia (Hamilton)

Muroena Russell, 1801, *Fish. Vizag.* **1** : 25, pl. 35 (named *Dondoo paum*). (Locality : a 1′11″ specimen taken from Ankapalle Lake)

Unibranchapertura cuchia Hamilton, 1822, *Fish. Ganges* 16, 363, pl. 16, fig. 4. (Type locality : Rivers and ponds in south-east parts of Bengal); Hora, 1929, *Mem. Indian Mus.* **7** : 185 (reference only).

Cuchia Taylor, 1831, *Edinburgh J. Sci.* **5** : 42-50 (Anatomy) ibid. **5** : 33-42 (Respiratory organs) ; 1835, *Isis* (Oken) 307-10.

Ophichthys punctatus Swainson, 1839, *Nat. Hist. Classif. Fish.* **2** : 336.

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Note:

No attempt has so far been made to study the variations in the vertebral counts of this species. Material from Burma should be specially examined in the context.

Amphipnous fossorius Nair

Amphipnous fossorius Nair, 1951, *Proc. Indian Acad. Sci.* **34**(B) (6): 311-316, 321, 326-327, figs. 1,7. (Type locality : Marshy areas in the paddy fields and banana plantations adjoining Karamanai River, Karamanai, Trivandrum, Kerala State)

Note:

The single specimen of *A. fossorius* that we have examined is devoid of scales in the anterior part of the body; the scales are arranged in distinct longitudinal rows in the posterior half. The skin in the anterior part of the body is smooth without any indication of scale pockets. According to Nair (1951) 'the body is covered by very minute cycloid scales . . .'; we feel that this character needs rechecking in the type material also. Unlike in *A. indicus*, the gill openings and the crescent-like opening is greatly arched. The longitudinal furrows on the ventral side of the branchial region of the head as in some of the true eels (e.g. *Moringua* etc.) are very characteristic of this species.

ACKNOWLEDGEMENTS

We are very grateful to Dr. S. Jones, Director, Central Marine Fisheries Institute, Mandapam Camp, for the facilities given for carrying out this study; to Dr. M. Mathias, Nagercoil, for the X-ray photographs of the specimens. To Mr. C. T. Samuel we are indebted for making available for examination a specimen of *Amphipnous fossorius* Nair. The senior author wishes to specially thank Mr. V. K. Chari, Curator, Natural History Section, Prince of Wales Museum of Western India, Bombay, for help rendered in the field at Mahableshwar. The photographs of the new fish given on plate II were taken by Mr. K. G. Nambiar of this Institute, and the junior author assisted in the preparation of the figures given in Plate I. The material on which the paper is based was collected by the senior author while Registrar at the Bombay Natural History Society.

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EXPLANATION OF PLATES

PLATE I

Amphipnous indicus sp. nov.

1. Lateral view of holotype 412 mm. long; 2. Head region showing lateral sensory canal system; 3. Middle of body showing scaleless condition as well as discontinuous sensory canal system along the midlateral part of the body; 4. Part of trunk and tail showing disposition of scales and discontinuous lateral sensory canal system along midlateral part of body; 5. Ventral view of head and anterior part of body; 6. Dissection showing both roof and floor of buccal cavity and pharynx and indicating the position of the aperture to the air chamber and its relation to the branchial slits; 7. Lateral dissection showing the position of the accessory air chamber; 8. Fourth branchial arch and attached plate-like organ composed of fused gill filaments; 9. Third branchial arch showing same structure as 8; 10. Lateral view of head with part of mucus coating removed to show glandular skin; 11. Patch of skin of head magnified to show pitted glandular nature; 12. Suprapharyngeal bone and its teeth; 13. Infrapharyngeal bone and its teeth; 14. Ventral view of part of trunk and tail showing disposition of scales.

Abbreviations : *aas* aperture of accessory air chamber; *an* anterior nostril; *as* accessory air chamber; *ba* cut ends of branchial arches; *bc* buccal cavity; *bpl* gill filaments fused to form gill plates; *br* branchial arches; *bs* branchial slits; *go* gill opening on one side; *gsk* glandular skin; *ios* infraorbital sensory canal; *ipt* infrapharyngeal bone and teeth; *ist* isthmus between gill openings; *ll* discontinuous lateral canal system on side of body; *md* mandibular band of teeth; *mds* mandibular sensory canal; *muc* layer of mucus covering on head; *mus* muscular body wall cut across; *mx* maxillary band of teeth; *oe* oesophagus; *pa* palatine band of teeth; *plg* post labial groove; *sc* scales; *spt* suprapharyngeal bone and teeth; *t* tongue; *v* vent.

PLATE II

Amphipnous indicus sp. nov.

A. Holotype, 412 mm. long; B. Ventral view of part of trunk and tail showing arrangement of scales; C. Lateral view of same, but showing more of the tail portion and complete encirclement of scales in the posterior part; D. Lateral view of head of paratype showing characteristic dorsal profile; E. Ventral view of same, with the skin cut to enable counting of branchiostegal rays.

Notes on some Corvidae from Nepal, Pakistan, and India

BY

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The following observations were made during a study of the Corvidae collected by the Harvard-Yale Expedition (1957-59) in the region about Pokhara, central Nepal, in the vicinity of Darjeeling, India, in various localities throughout East Pakistan, and in northern West Pakistan.

ACKNOWLEDGEMENTS

For permission to collect and for assistance in many ways I am grateful to the Ministry of Foreign Affairs of Nepal and to the Zoological Surveys of Pakistan and of India. A. R. Ranjha and M. S. U. Siddiqi were of particular help in our work in Pakistan, as was H. Khajuria in India.

I am indebted to the following for lending specimens in their care : James D. Macdonald of the British Museum (Natural History), Robert W. Storer of the Museum of Zoology of the University of Michigan, Melvin Traylor of the Chicago Natural History Museum, and Charles Vaurie of the American Museum of Natural History.

Humayun Abdulali, Honorary Secretary of the Bombay Natural History Society, very generously provided me with descriptions and measurements of that institution's series of *Dendrocitta vagabunda.*

DENDROCITTA VAGABUNDA

Dendrocitta vagabunda exhibits much seasonal, individual, and geographical variation. In spite of the fact that it is a relatively common bird over much of the Indian sub-continent, it has not been collected systematically, either geographically or seasonally. Its patterns of variation are, therefore, difficult to analyse and the present study can only attempt to outline the trends and problems.

The following seems to be the general pattern of variation. The birds from Bengal, nominate *vagabunda,* are of moderate size and richly coloured. North-westward in the lower ranges of the Himalayas the birds remain generally dark, but there is a cline toward larger size which reaches its extreme in the westernmost Himalayas. From Bengal westward in the plains there is a trend toward paler coloration and larger size, but the extreme size of the north-west Himalayas is nowhere reached. South-westward the cline is toward paler and smaller birds, with the smallest birds of the sub-continent (*D.v. parvula*)[1] occurring on the west coast from Mangalore to Cape Comorin.

Blyth (1846, p. 30), the first to be aware of geographical variation in the species, described *pallida* from a specimen in a collection of birds purchased in Calcutta and said to have come from the ' Western Himalaya'. The form was described as differing from ' *rufa* ' (now nominate *vagabunda*) in its paler colouring and ' considerably smaller size'. The wing length was given as five and one half inches (140 mm.) and the tail as eight and three-quarter inches (222 mm.).

Ticehurst (1922, p. 537), in examining a large series of Indian tree-pies, mainly from the north, concluded that while *pallida* is distinguished from *vagabunda* by its paler colour, it is not much smaller, as Blyth noted, but is ' considerably larger'. He named Simla as the type locality for *pallida* and Calcutta as the type locality for *vagabunda.*

Ticehurst's assumption that Blyth erred in describing *pallida* as a small bird, and his designation of Simla as the type locality, seem to be two unfortunate errors.

Although Blyth's bird was said to have come from the Himalayas, his description fits *D. v. parvula* of the south-west coast, or possibly *D. v. vernayi* of southern and south-eastern India. Both these races are paler than nominate *vagabunda* and are smaller, with their size range encompassing the measurements (wing 140 mm. ; tail 222 mm.) given in the original description of *pallida.*

Designating Simla as the type locality of *pallida* compounded the error, since this falls within the range of a large and dark Himalayan population which ranges from the vicinity of Hazara District, or possibly somewhat farther north-west, south-eastward roughly to Dehra Dun.

While it seems probable that the type of Blyth's *pallida* was a specimen of the race now known as *parvula*, or possibly of *vernayi*, some element of doubt remains since it is impossible to be certain that Blyth's bird did not come from the ' Western Himalaya'. It could, conceivably, have been an unusually small specimen from the western lower foothills. I am, therefore, reluctant to shift the name *pallida* from the population of the north-western region of the sub-continent, where it has been applied for more than 100 years, to either of the races of the south. The best course would appear to be to designate a new type locality for *pallida* since Simla, within the range of a large dark form in no way resembling *pallida*, certainly could not have been the provenance of Blyth's specimen. I hereby designate Galkund, Surat Dangs, as the type locality of *pallida*. This locality falls within the range of a moderate size, pale population much more nearly approaching Blyth's description.

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[1] Whistler & Kinnear (1932) described *parvula* as being much smaller than *vagabunda* but similar to it in colour. However, Abdulali (*in litt.*) informs me that the three specimens of *parvula* in the Bombay Natural History Society's collection are considerably paler than the nominate form, and in fact are very close to *pallida.* I have seen no specimens of *parvula.*

The large, dark birds of the north-western Himalayas lack a name and for these I propose :

Dendrocitta vagabunda bristoli subsp. nov.

Type : Adult male, No. 185, 365, Museum of Comparative Zoölogy, Harvard College, Cambridge, Massachusetts, collected at Jabri (*c.* 11 miles west of Murree), alt. 900 metres, Hazara District, West Pakistan, by Raymond A. Paynter, Jr., 17 December 1958.

Diagnosis : The largest of the races of *D. vagabunda*, nearest to *pallida*, but with a considerably longer tail and a somewhat longer wing ; richly coloured, but slightly paler than the nominate form.

Range : Lower ranges of the westernmost Himalayas from Hazara District, West Pakistan, south-east to the vicinity of Dehra Dun, India.

Measurements : The wing and tail measurements of the type are 177.0 and 363.0 mm. respectively ; these measurements for two adult male topotypes are 174.0 and 342.0 mm., and 179.0 and 334.0 mm. The wings of three adult female topotypes are 174.0, 166.0, and 163.0 mm. ; the tails of the former two are 349.0 and 312.0 mm.

Remarks : The characters of the race are most pronounced at the north-western limit of its range, which probably is also the limit of the distribution of the species. To the west, south, and south-east there are marked clines toward the contiguous races *D. v. pallida* and *D. v. vagabunda*.

The race is named for Melvin Lee Bristol who, with enthusiasm and industry, did much to make the Harvard-Yale Expedition a success.

Specimens Examined : bristoli : 12 ♂, 10 ♀, and 4 ? from Jabri, Hazara Dist. ; Rawalpindi Dist. ; Jhelum Dist.; Kangra ; Simla ; and Dehra Dun. *pallida* : 28 ♂, 19 ♀, and 13 ? from 'plains near Ambala' ; Lahore ; Keshapur ; Ludhiana ; Ferozepore ; Sargodha ; Surat Dangs ; Sirohi ; Kathiawar ; Junagadh ; Hyderabad (Sind) ; Khinjar Lake (Sind) ; Soneri Lake (Sind) ; and Kohat. *vagabunda* : 5 ♂, 6 ♀, and 1 ? from vicinity of Pokhara (central Nepal) ; Bastar Dist. ; Cachar ; and Sylhet Dist.

In addition to the above series, Humayun Abdulali sent me descriptions and measurements of 16 males and ten females, representing all

TABLE I

Measurements of adults of the races of *Dendrocitta vagabunda* on the Indian Sub-continent

Character	Race	Sex	No. of speci-mens	Mean	$S_{\bar{x}}$	Range
Wing (flattened)	*bristoli*	♂	12	169.9 mm.	2.1	157.0–179.0 mm.
		♀	7	163.8	1.5	158.0–174.0
	pallida	♂	38	161.3	0.8	149.0–172.5
		♀	28	153.5	1.0	144.0–165.0
	vagabunda	♂	13	153.6	1.6	146.0–168.0
		♀	7	153.5	1.1	136.5–161.0
	vernayi	♂	2	147.5	—	146.0–149.0
		♀	3	144.3	3.1	138.0–149.0
	parvula	♂	2	139.5	—	136.0–143.0
		♀	2	136.0	—	131.0–141.0
Tail	*bristoli*	♂	11	312.6	9.4	265.0–363.0
		♀	5	304.5	14.0	269.0–349.0
	pallida	♂	36	262.3	3.1	217.5–297.0
		♁	27	243.7	3.1	219.0–279.0
	vagabunda	♂	12	237.9	4.2	216.0–263.0
		♀	5	224.6	7.1	207.0–240.0
	vernayi	♂	2	211.5	—	200.0–223.0
		♀	2	188.0	—	187.0–189.0
	parvula	♂	1	184.0	—	—
		♀	2	202.0	—	201.0–203.0
Weight	*bristoli* (type locality)	♂	3	143.5 gm.	1.6	140.6–146.2 gm.
		♀	3	132.0	6.8	119.5–143.0
	vagabunda	♂	3	119.0	4.9	112.0–128.3
		♀	3	107.0	5.8	98.3–117.8

five of the sub-continental races, contained in the collections of the Bombay Natural History Society.

NUCIFRAGA CARYOCATACTES

In a review of the Himalayan races of the Nutcracker, Biswas (1950) states that *N. c. yunnanensis*, now considered a synonym of *macella* (*vide* Vaurie, 1954), could be differentiated from *hemispila* by its darker colour, smaller spots, and heavier bill. Vaurie (1959) distinguished *macella* from *hemispila* by these same characters, noting also that the frequency of spotting was reduced ; he omitted mention of a difference in bill size.

I concur that *yunnanensis* should be merged with *macella*, but I find *macella* a relatively weak race, not nearly so distinct from *hemispila* as would seem to be indicated by earlier workers. No difference in bill size is apparent in the 35 specimens of both races examined by me. Colour is an extremely variable character, as noted by Sanford & Mayr (1940), with pronounced seasonal changes, as well as foxing, obscuring any differences which might exist between the races. There remain as characters only the size and frequency of the spots. I agree that the spotting is heavier and more numerous in *hemispila* than in *macella*, although even these characters are variable.

Biswas (1950) believed that birds from Nepal, Sikkim, Darjeeling, Bhutan, south-eastern Tibet, northern Assam, and northern Burma were referable to *yunnanensis* (now *macella*), rather than to *hemispila* which has long been considered to range from about Kashmir eastward through the Himalayas. Vaurie (1959) followed Biswas in listing *macella* as the form from Nepal eastward. My eastern Himalayan material is limited to five fresh specimens from Darjeeling District ; these are definitely *hemispila*. Rand & Fleming (1957) referred their series of nine birds from central Nepal to *hemispila* also. Thus it appears, contrary to Biswas (1950) and Vaurie (1959), that *hemispila* occurs east at least to Darjeeling.

CORVUS MACRORHYNCHOS

C. m. intermedius, the race extending from Afghanistan through the Himalayas to Nepal, differs from *levaillantii*, the form of Assam, West Bengal, East Pakistan, the Andamans, Burma, and northern Thailand, in having a distinctly longer tail and shorter, thicker bill, and a somewhat longer wing (Table II). This follows the usual pattern wherein most montane races have longer wings and tails, and shorter bills (Allen's rule), than their lowland counterparts.

It is generally assumed that any intraspecific differences in the linear dimensions of the wings and tail reflect differences in body size (=weight). In other words, a long-winged, long-tailed race is presumed to be a heavier-bodied form than a short-winged, short-tailed race. While this assumption is valid in the majority of instances, an increase in body mass is not necessarily always accompanied by an increase in the length of the wings and tail, or vice versa. The linear measurements of these appendages may remain relatively constant while body weight varies. This has been documented by Amadon (1943).

Table II

Measurements of adults of *Corvus macrorhynchos levaillantii* and *C. m. intermedius*

Character	Race	Sex	No. of specimens	Mean	$S_{\bar{x}}$	Range
Wing (flattened)	*levaillantii*	♂	3	326.1 mm.	8.7	308–335 mm.
		♀	9	307.1	5.3	280–329
	intermedius	♂	7	335.9	3.9	320–349
		♀	10	323.9	2.9	309–338
Tail	*levaillantii*	♂	3	190.0	5.2	181–190
		♀	8	178.7	3.7	165–192
	intermedius	♂	6	219.2	4.7	199–241
			10	204.9	3.0	185–215
Culmen (from base)	*levaillantii*	♂	3	68.0	.6	67–69
		♀	9	62.2	.5	60–65
	intermedius	♂	7	60.7	.6	58–63
		♀	10	55.0	.8	50–59
Weight	*levaillantii*	♂	3	602.2 gm.	23.7	554.8–625.6 gm.
		♀	9	502.0	16.4	419.3–565.7
	intermedius	♂	7	522.4	15.1	460.4–582.3
		♀	10	456.3	9.6	392.0–495.1

The next step beyond a positive relation between wing and tail length and the body mass, or stage where there is no change in appendicular measurements while there is variation in weight, is that of a negative relation between weight and the size of the wings and tail. This is clearly demonstrated by a series of *C. m. intermedius* from East Pakistan and a series of *C. m. levaillantii* from central Nepal and from Swat, Kurram Agency, and Hazara District, West Pakistan (Table II). Here the long-winged, long-tailed montane race is distinctly smaller in body mass than the short-winged, short-tailed lowland form. The significance of this phenomenon is obscure. I am not aware of it having been documented before, but similar situations undoubtedly will be found when the weights of birds are better known.

WEIGHTS OF SOME CORVIDAE

There are few data available on the weights of Asiatic birds, although this is an area of research of considerable interest and potential importance. Future students may find the following compilation of use :

TABLE III

Weights of adults of some Corvidae from the Indian Sub-continent

	Sex	No. of specimens	Mean	$S_{\bar{x}}$	Range	Locality
			gr.		gr.	
Garrulus glandarius interstinctus	♂	1	128.8	—	—	Darjeeling Dist., India.
Garrulus lanceolatus	♂	7	103.5	1.7	97.2–108.5	Pokhara, Nepal; Kaghan Valley, Kurram Agency, and Swat, W. Pak.
	♀	4	96.9	2.7	90.8–103.0	
Urocissa flavirostris cucullata	♂	2	163.4	—	162.6–164.2	Vicinity Pokhara, Nepal; Kaghan Valley, W. Pak.
	♀	2	153.1	—	143.7–162.5	
Urocissa flavirostris flavirostris	♀	2	137.4	—	131.8–143.0	Darjeeling Dist., India.
Urocissa erythrorhyncha occipitalis	♂	3	214.7	8.2	205.0–231.1	Pokhara and vicinity Nepal.
	♀	2	201.5	—	195.8–207.2	
Cissa chinensis chinensis	♂	2	132.7	—	132.0–133.4	Pokhara, Nepal; Kalimpong Dist., India.
	♀	3	122.3	1.2	120.0–124.0	
Dendrocitta formosae occidentalis	♀	1	104.4	—	—	Hazara Dist., W. Pak.
Dendrocitta formosae himalayensis	♂	22	106.4	1.5	90.3–121.0	Pokhara and vicinity Nepal; Chittagong Hill Tracts, E. Pak.; Kalimpong Dist., India.
	♀	12	99.3	2.0	89.0–105.9	
Pica pica bactriana	♂	1	248.7	—	—	Kurram Agency, W. Pak.
	♀	5	203.0	4.6	190.3–211.7	
Nucifraga caryocatactes multipunctata	♂	1	190.7	—	—	Kaghan Valley and Swat, W. Pak.
	♀	3	159.1	5.7	147.8–165.4	
Nucifraga caryocatactes hemispila	♂	2	209.6	—	205.6–213.7	Darjeeling Dist., India.
	♀	2	183.8	—	183.3–184.3	
Pyrrhocorax graculus digitatus	♂	1	243.7	—	—	Kaghan Valley, W. Pak.
	♀	1	208.1	—	—	
Corvus monedula soemmerringii	♂	1	265.0	—	—	Kaghan Valley, W. Pak.
	♀	1	235.0	—	—	
Corvus splendens splendens	♂	2	336.0	—	310.0–362.1	Pokhara and vicinity Nepal; Sundarbans, E. Pak.
	♀	5	277.8	8.7	252.0–304.5	

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Entomological Survey of Himalaya

Part XXVI. A Contribution to our Knowledge of the Geography of the High Altitude Insects of the Nival Zones from the North-West Himalaya[1]

PART 1

BY

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(*With eleven text-figures*)

I. INTRODUCTION

The zoogeographical considerations of the nival insect fauna from the north-west Himalaya, outlined here, are based on our four years' work in the School of Entomology, St. John's College, Agra. The nival insects belong to an ecologically specialized, cold-adapted, mountain-autochthone fauna, inhabiting the montane tundra beyond the timber line (Fig. 1), above an elevation of 3000 metres and extending to over 6000 metres above m.s.l. We have recently described the field ecology of these insects (100).

The earliest collections of the high altitude insects from the region were probably made by von Hügel (72). His collections, comprising several hundred species, were described by various specialists in Europe, like Kollar and Redtenbacher (80). The next important attempt at collecting in the region was undoubtedly by the Yarkand Political Mission. To Col. Stoliczka, the renowned geologist and naturalist of the Yarkand Mission, should really go the chief credit for discovering the wealth of insect life in these inaccessible and extremely inhospitable regions. His collections were described by various eminent European specialists (12, 13, 28, 107, 108, 125, 143). Guy Babault, the celebrated French naturalist, who travelled through Kangra, Kulu, and Lahaul valleys, through Ladakh and parts of Kashmir in 1914, brought back fairly large collections of high altitude species. The Orthoptera from his collections were identified by Uvarov (151). The large collection of Carabidae was described by Andrewes (2). The Curculionidae were worked out by Hustache (73) and the Histeridae by Desbordes (24). In recent years the Yale University North-India Expedition has also made valuable collections of the high altitude insects, mainly from Ladakh (3, 21, 23, 74). Some collections of these insects were also made by the Italian Karakorum Expedition (14, 47, 48, 111) and by the German Nanga Parbat Expedition (34). A special study of the high altitude insects of the NW. Himalaya was initiated some years ago by the first author in the School of Entomology, St. John's College, Agra. The three entomological expeditions to the NW. Himalaya, organized and led by him, brought back over 15,000 specimens of large numbers of species of the nival insects. Some of the results of the work of the three expeditions have already been published (8, 9, 10, 51, 56, 77, 95-101, 130-140).

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[1] For parts I-XXIII see References Nos. 8-10, 51, 56, 77, 90-99, 101, 130-133, 136-140 ; part XXIV is appearing in *Proc. National Acad. Sciences, India,* and XXV in *Proc. Zool. Soc.*

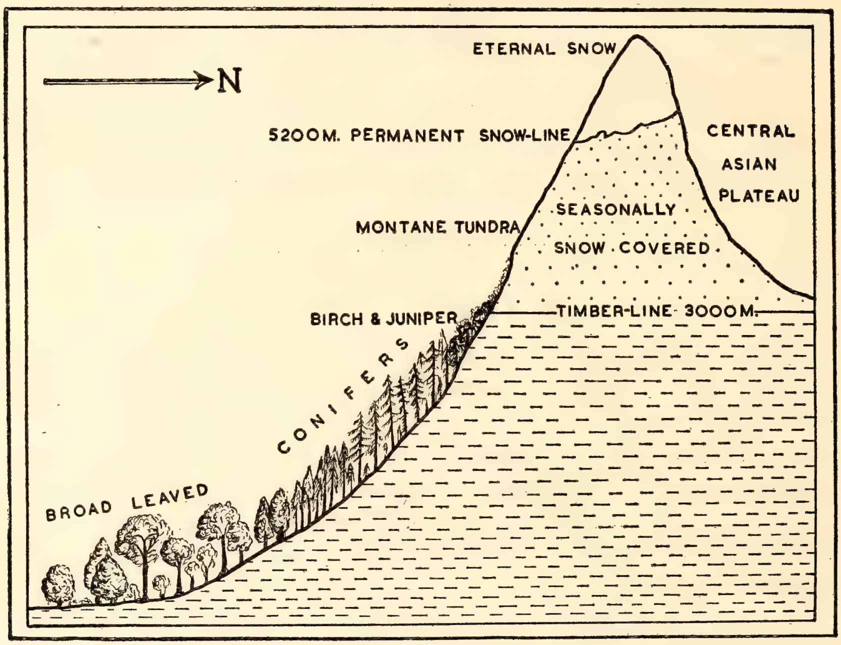

Fig. 1. A simplified diagram of the region of the north-west Himalaya, showing the zone of the montane tundra above an elevation of 3000 metres above mean sea level. This seasonally snow-covered zone is the home of the nival insect fauna. (*Not drawn to scale*).

The localities from which the nival insects have so far been collected are listed below under the three natural drainage areas of the NW. Himalaya, viz. the Indus area, the Chenab-Beas area, and the Jhelum area (Fig. 2). In the following pages we have briefly discussed the known distribution of about 400 species so far found inhabiting the nival zones in the region. Although this represents a fraction of the total nival species still awaiting discovery, our account of the basic distributional patterns is not likely to be affected by future additions. The general pattern of distribution conforms to the known characters of high mountain fauna, but most of the peculiarities are more or less greatly exaggerated in the case of the massive NW. Himalaya. Zoogeographical analysis shows a high degree of endemism and the great predominance of the Palaearctic faunal elements. Some of the limiting factors in the distribution of nival insects are briefly outlined. On the basis of the differences in the general species composition, the region is subdivided into three faunal provinces, which agree with the three natural drainage areas. The available evidence indicates mainly the Pliocene origin of endemism from an Angaran (central Asiatic) stock *pari passu* with the third major phase of the uplift of the NW. Himalaya and the Pleistocene survival of the nival species on nunataks. Some endemites have also risen during the Pleistocene and there are a few post-Pleistocene endemites also.

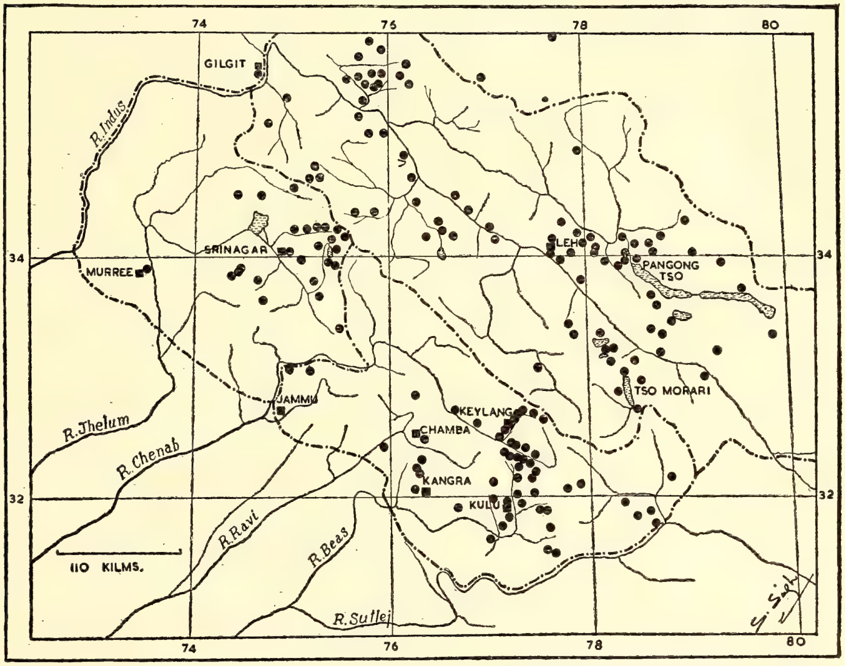

Fig. 2. Map of the region of the north-west Himalaya, showing the localities from which the nival insects have been collected so far.

ACKNOWLEDGEMENTS

We take this opportunity of expressing our cordial thanks to the members of the three entomological expeditions for their willing cooperation and team work. We are particularly indebted to the authorities of St. John's College, Agra, for facilities and encouragement. We are also grateful to the Agra University for part financial assistance for the expeditions. Our thanks are also due to various specialists for identification of the material. We are grateful to the authorities of the Carnegie Institution, Washington, U.S.A., for important literature.

LOCALITIES FROM WHICH NIVAL INSECTS HAVE BEEN COLLECTED

INDUS DRAINAGE AREA

1.	Alchori	Shigar Valley 75° 39′ E., 35° 32′ N.
2.	Anem La	Somewhat E. of NW. end of Pongong Tso, near 78° 45′ E., 34° N.
3.	Baltoro Glacier	76° 15′ to 76° 30′ E., 35° 45′ N.
4.	Bao and Shaple	Near Shyok to NE. of Leh in Ladakh
5.	Bardumul	W. of Baltoro Glacier, 76° 1′ E., 35° 38′ N.
6.	Biaho Valley	Tributary of Shigar River flowing into Indus
7.	Boorgi Nulla	Tributary of R. Suru, S. of Skardu
8.	Braldo Valley (including Braldotal, Askole, Kro Brok and Dusu)	In Baltistan
9.	Burzil Chauki	In Deosi Plain, 75° 5′ E., 34° 50′ N.
10.	Chang Chenmo	Tributary of R. Shyok, N. of Pongong Tso
11.	Chang La	77° 56′ E., 34° 3′ N.; E. of Leh in Ladakh
12.	Chhota Deosi	Between R. Dras and Boorgi Nulla
13.	Chongo Hot Spring	In Braldo Valley, 75° 48′ E., 35° 40′ N.
14.	Chusul	S. of Pongong Tso, 78° 40′ E., 33° 36′ N.
15.	Dakar	On Tibetan border in Ladakh
16.	Damb Guru	Somewhat to N. of E. end of Pongong Tso 78° 54′ E., 33° 58′ N.
17.	Daulad Begoldi	SE. of Karakorum Pass
18.	Deosi (Lalpani)	In R. Dras drainage area
19.	Digar Polu	On S. slope of Ladakh Range; NE. of Leh
20.	Doyan	Near Nanga Parbat on R. Astor, on route to Gilgit; 74° 48′ E., 35° 30′ N.
21.	Dumiltar	Glacier, E. of Punmah Valley and N. of Braldo Valley
22.	Dras	Between Zojila Pass and Kargil, on road to Leh in Ladakh; 75° 45′ E., 34° 25′ N.
23.	Ghulam Bagh	Near Chushod (also called Shushot), on left bank of R. Indus in Ladakh; 77° 44′ E. and somewhat north of 34° N.
24.	Gilgit	74° 18′ E., 35° 58′ N.
25.	Igu	Right bank of R. Indus above Leh in Ladakh
26.	Kangral	About 13 km. E. of Mulbek
27.	Karbu	Near Mulbek in Indus Valley, Ladakh
28.	Kardong Pass	N. of Leh on Ladakh Range
29.	Kargil	On the left bank of R. Suru on road to Leh from Srinagar, in Ladakh
30.	Karpet	On S. shore of Pongong Tso, in Ladakh
31.	Kastet La	Between Mitpal Tso and Yaye Tso, in Ladakh; 78° 32′ E., 33° 23′ N.
32.	Kayann La	In Koh Lungpa Valley, between Leh and Shyok, Ladakh
33.	Khalatse	Between Kargil and Leh, right bank of R. Indus, Ladakh; 76° 53′ E., 35° 36′ N.
34.	Kushumul	Shigar Valley, 75° 35′ E., 35° 36′ N.
35.	Kutie Pass	N. of Karakorum Pass

36.	Kyam La and Kyam Hot Spring	Near E. of R. Chang Chenmo, N. of Tso Pongong
37.	Kyang La	SE. of the confluence of R. Chang Chenmo and R. Shyok, in Ladakh ; 78° 25′ E., 34° 9′ N.
38.	Kro Brok	Braldo Valley, about 8 km. E. of Chongo Hot Spring
39.	Lac Sale (Salt Lake), also called Tso Kar.	NW. of Tso Morari in Rupshu
40.	Leh	Capital of Ladakh on the right bank of R. Indus
41.	Lopsang Bransa	N. of the Baltoro Glacier ; 76° 18′ E., 35° 48′ N.
42.	Lukung	Somewhat N. of NW. end of Pongong Tso; 78° 23′ E., 34° N.
43.	Marsimik La	N. of NW. end of Pongong Tso ; 78° 40′ E., 34° 12′ N.
44.	Matyan	On road between Zojila Pass and Dras in Ladakh
45.	Mitpal Tso	S. of Pongong Tso, between Pangur Tso and Yaye Tso
46.	Mulbek	In Ladakh, 76° 25′ E., 34° 25′ N.
47.	Mundu	Mundu Glacier, S. of the Baltoro Glacier, near 76° 15′ E., 35° 45′ N.
48.	Mustag	N. of the Baltoro Glacier ; 76° 15′ E., 35° 50′ N.
49.	Nanga Parbat area, including	Partabgarh and Chamura (German Nanga Parbat. Expedition Collections)
50.	Nima Mud	On the right bank of R. Indus, below S. end of Pongong Tso in Ladakh
51.	Nurla	E. of Khalatse on the right bank of R. Indus ; 76° E., 35° 18′ N.
52.	Nyangtsu	Between Chang Chenmo and Pongong Tso ; 78° 50′ E., 34° 2′ N.
53.	Nyangri	78° 50′ E., 34° 2′ N.
54.	Olthingthang	Indus Valley, left bank of Suru tributary of R. Indus and near its confluence with the latter
55.	Ororotse Tso	S. of the confluence of Chang Chenmo and Shyok, in Ladakh ; 78° 28′ E., 34° 15′ N.
56.	Pango	Near to and somewhat W. of Mulbek in Ladakh
57.	Pongong Valley	NW. of Pongong Tso
58.	Parkutta	Indus Valley, E. of Skardu ; 75° 55′ E., 35° 5′ N.
59.	Peldo La	N. end of Tso Morari
60.	Phuga Hot Spring	N. end of Tso Morari ; 78° 20′ E., 33° 12′ N.
61.	Punmah Valley	Includes many localities like Shimtsa, Punmah Tal, Skiniltolmosa, Tsok, etc., N. of Braldo Valley
62.	Renka La	Between Mitpal Tso and Yaye Tso, S. of Pongong Tso.
63.	Saser La	Above Shyok, between and nearer to 78° than 77° E.
64.	Shaksgan Valley	N. of Karakorum Range
65.	Shakya La	Near Shyok, W. of Bao and to the N. of E. of Leh
66.	Shergol	About 8 km. W. of Mulbek
67.	Shera La	77° 88′ E., and 33° 55′ N.
68.	Shigar Valley	Opposite Skardu in Baltistan

69.	Shimsha	Suru Basin near Kargil
70.	Skardu	Indus Valley
71.	Skoro La	Baltistan, 75° 48′ E., 35° 33′ N.
72.	Slope opposite Mulbe Gompa in Ladakh	
73.	Spitok (Pitok)	Right bank of R. Indus and S. of Leh
74.	Spring below Fotu La	E. of Mulbek
75.	Sta-rtsk-puk-Tso	SE. Tso Kar.
76.	Suru Basin	Indus drainage area
77.	Tagalang La	77° 45′ E., 33° 30′ N.
78.	Tangyar	NE. of Leh and S. of R. Shyok; 77° 52′ E., 34° 15′ N.
79.	Tankse to Chagra	On R. Tankse, a feeder of R. Shyok, near Shyok; 78° 10′ E., 34° 2′ N. and Chagra 78° 28′ E., 34° 5′ N.
80.	Tankse to Mugleb	About 10 km. E. of Tankse
81.	Thla Brok	Left bank of Braldo stream, 75° 52′ E., 35° 38′ N.
82.	Thangman Tso	East Ladakh
83.	Tograma Tso	Near Padam, 76° 52′ E., 33° 28′ N.
84.	Tolti	E. of Parkutta, 76° 5′ E., 34° 2′ N.
85.	Tsak-shang and Tsak-ra	On road from Tso Morari to Tso Kar in Rupshu
86.	Tso Morari	In Rupshu; 78° 10′ E., 32° 30′ N.
87.	Tso Nyak	E. of Pongong Tso
88.	Urdukas	Near Baltoro Glacier; 76° 17′ E., 35° 45′ N.
89.	Widukas	In Braldo Valley
90.	Zarra	S. of Tagalang La; 77° 40′ E., 33° 15′ N.
91.	Zaskar	N. of main crest line of the Great Himalaya.

CHENAB-BEAS DRAINAGE AREA

1.	Baijnath	On road from Palampur to Jogendranagar on Dhauladhar Range, S. slope; 76° 38′ E., 32° 2′ N.
2.	Bahaura	On right bank of R. Beas near and S. of Kulu (Sultanpur)
3.	Baralacha La	On Great Himalaya, main pass connecting Lahaul with Ladakh, with sources of Chandra on S. and Bhaga on N.; 77° 27′ E., 32° 45′ N.
4.	Batote	On road from Jammu to Srinagar, S. of Banihal Pass; 76° 15′ E., 33° 2′ N.
5.	Bhabu Pass	W. of Sultanpur (Kulu)
6.	Chamba	Upper R. Ravi Valley on N. slope of Dhauladhar Range
7.	Chhatru	Chandra Valley (Lahaul), opposite Hamta Gorge; 77° 23′ E., 32° 20′ N.
8.	Cimur	Bhaga Valley (Lahaul); 77° 23′ E., 32° 20′ N.
9.	Dalhousie	On Dhauladhar Range; 76° 8′ E., 32° 15′ N., in Gurdaspur Dt., Punjab
10.	Dharamsala	Kangra Dt., Punjab, on Dhauladhar Range; 76° 20′ E., 32° 13′ N.
11.	Dhauladhar	N. of Dharamsala
12.	Dhorni	Upper Chandra Valley (Lahaul), between Koksar and Chhatru; 77° 18′ E., 32° 22′ N.

13.	Dibi Bokri and Runi Tach	In Spiti Valley
14.	Gharry	Parbati Valley (Punjab)
15.	Gondhla	Upper Chandra Valley (Lahaul), on road from Koksar to Keylang; 77° 2′ E., 32° 30′ N.
16.	Gramphu	Upper Chandra Valley (Lahaul), below Rohtang Pass and in front of Kulti Nal; 77° 15′ E., 32° 23′ N.
17.	Hamta Gorge	Upper Chandra Valley (Lahaul) after descent from Hamta Pass and E. of Chhatru, on Pir Panjal Range
18.	Hamta Jot and Hamta Pass	Pir Panjal Range, on Manali-Kanzam La route, 77° 21′ E., 32° 17′ N.
19.	Jalori Pass	On route from Simla to Kulu, about 36 km. from the junction of Manali-Kulu road and Simla-Kulu road at Aut
20.	Jibhi	6 km. from Jalori Pass toward Kulu
21.	Kandi	NE. of Mandi (a pass on way to Kulu)
22.	Kangra	Headquarters of Kangra District, Punjab (Kangra Valley)
23.	Kareri Lake	N. of Dharamsala on the S. slope of Dhauladhar Range
24.	Keylang	Capital of Lahaul Valley on R. Bhaga; 77° 2′ E., 32° 35′ N.
25.	Khoksar	Upper Chandra Valley (Lahaul), below Rohtang Pass on road to Keylang
26.	Kote	Upper Beas Valley, on road from Manali to Rohtang Pass; 77° 13′ E., 32° 20′ N.
27.	Kulti Nal	Chandra Valley (Lahaul), on Great Himalaya Range, N. slope, opposite Rohtang Pass, site of a large Pleistocene Valley Glacier, with the present Kulti Ice Fall or Seragru Ice Fall
28.	Laka Pass	On Dhauladhar Range N. of and above Dharamsala; 76° 23′ E., 32° 18′ N., on road to Chamba
29.	Mandi	On left bank of R. Beas on way to Kulu from Kangra
30.	Manikaran	Parbati Valley (Kulu Division), Hot Spring; 77° 22′ E., 32° 2′ N.
31.	Marhi	Below Rohtang Pass on Pir Panjal
32.	Naggar	Beas Valley N. of Kulu on way to Manali
33.	Namu	On S. slope of Great Himalaya, in Upper Chenab Valley, below Baihali Jot Peak and near Triloknath; 76° 53′ E., 32° 45′ N.
34.	Nilang Pass	Spiti
35.	Pangi	Sutlej Valley, N. of Chini on Hindustan Tibet road; 78° 16′ E., 31° 36′ N.
36.	Parbati Valley	In Kulu Division, Punjab
37.	Patseo	Bhaga Valley (Lahaul); 77° 15′ E., 32° 45′ N.
38.	Peak W. of Rohtang Pass (Beas Rikhi Peak)	77° 14′ E., 32° 22′ N.
39.	Pir Panjal Range opposite Kulti Nal	
40.	Pulga	At the end of the Parbati Valley

41.	Purana Khoksar Nal	In Great Himalaya, above Chhatru, Upper Chandra Valley, with Sonapani Glacier and Seri Ice Fall
42.	Ramban	River Chenab on way to Srinagar from Jammu.
43.	Rahla	Upper Beas Valley below Rohtang Pass; 77° 12′ E., 32° 20′ N.
44.	Rohtang Pass	On Pir Panjal Range on way to Lahaul and Keylang from Manali; 77° 15′ E., 32° 23′ N.
45.	Runang and Hungrung Pass	In Spiti drainage area
46.	Rohtang Valley	Upper Beas Valley; source of R. Beas; on the S. slope of Pir Panjal Range
47.	Seraj	Kulu area N. of Larji
48.	Sidu	Chandra Valley (Lahaul); 77° 8′ E., 32° 22′ N.
49.	Solang Valley	W. of Manali in Kulu Valley
50.	Sumdeo	Bhaga Valley (Lahaul); 77° 13′ E., and 32° 40′ N.
51.	Tandi	At the confluence of Bhaga and Chandra, in Lahaul Valley; 76° 58′ E., 32° 34′ N.
52.	Taulin Pass to Shipki Pass	In Spiti drainage area
53.	Tchary-Joni	End of the Parbati Valley in Kulu Division of Punjab.
54.	Thirot	Upper Chenab Valley; 76° 47′ E., 32° 39′ N.
55.	Tsho-Ti	End of Parbati Valley
56.	Zingzingbar	Bhaga Valley (Lahaul); 77° 20′ E., 32° 48′ N.

JHELUM DRAINAGE AREA

1.	Apharwat	S. of Khilanmarg, on Pir Panjal Range (Kashmir)
2.	Baltal	Near and somewhat E. of Sonemarg in the Sind Valley (Kashmir)
3.	Gagarbal	Between Kangan and Sonemarg in the Sind Valley
4.	Gond	Sind Valley; 75° 5′ E., 34° 18′ N.
5.	Goorai Valley	N. of Tragbal Pass (Kashmir)
6.	Gulmarg	Kashmir, 74° 55′ E., 34° N.
7.	Kangan	Sind Valley; 74° 55′ E., 34° 18′ N.
8.	Khilanmarg	On Pir Panjal Range near Gulmarg, Kashmir, approximately about 74 °25′ E., 34° N.
9.	Kolahoi Glacier	Kashmir; 75° 25′ E., 34° 10′ N.
10.	Lake Vishnshar	Near and N. of Avantipur, Kashmir, on route to Srinagar
11.	Liddar Valley	Kashmir, Liddar tributary of R. Jhelum
12.	Liddarwar	S. of Kolahoi Glacier
13.	Prang	Sind Valley, near Sonemarg
14.	Razdhingan	Near Sonemarg
15.	Sintan Pass	E. of Verinag; 75° 35′ E., 33° 30′ N.
16.	Sonemarg	75° 18′ E., 34° 20′ N.
17.	Songam	Sind Valley
18.	Srinagar	Kashmir Valley; 74° 35′ E., 34° 2′ N.
19.	Tragbal Pass	74° 40′ E., 34° 30′ N.
20.	Yusimarg	E. of Gulmarg on S. slope of Pir Panjal Range
21.	Zoji La	On road to Leh from Srinagar; 75° 30′ E., 34° 20′ N.

II. THE NIVAL INSECT FAUNA

Nearly 400 species, belonging to 14 orders, occur above an elevation of 3000 metres. The number of species and their percentage abundance in different orders are summarized in Table I (Fig. 3).

TABLE I

Analysis of abundance of species of different Orders of the nival insect fauna

Serial No.	Order	Number of species	Percentage
1.	Plecoptera	5	1.27
2.	Odonata	4	1.01
3.	Orthoptera	14	3.30
4.	Dermaptera	3	0.76
5.	Heteroptera	17	4.50
6.	Homoptera	1	0.25
7.	Coleoptera	186	48.80
8.	Hymenoptera	36	8.10
9.	Neuroptera	1	0.25
10.	Trichoptera	11	2.50
11.	Lepidoptera	91	22.60
12.	Diptera	7	1.70
13.	Thysanura	3	0.76
14.	Collembola	15	3.80

Total number of nival species = 394

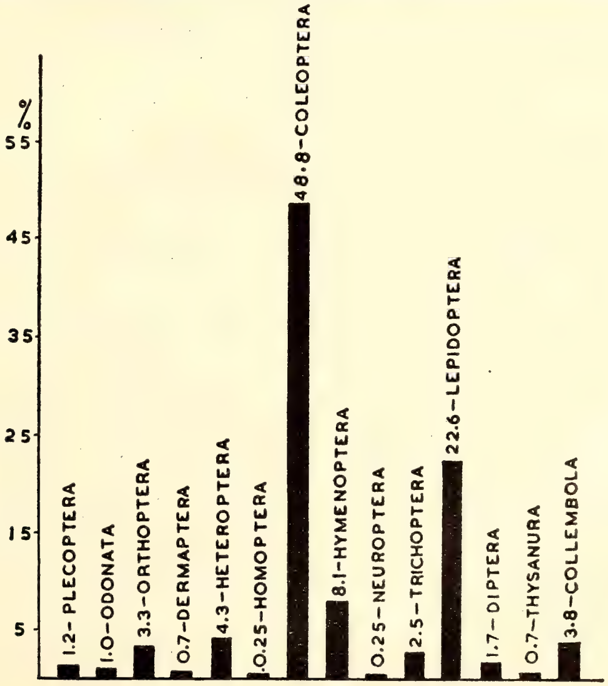

Fig. 3. The total nival insects from the north-west Himalaya.

About half the known nival species belong to Coleoptera and nearly one-fourth to Lepidoptera. Though the Diptera, so far described from the region, seem to constitute less than 2.0% of the total nival insects, the order is however extremely abundant, especially at extreme high altitudes. Recent experience of the three entomological expeditions (100) has shown that no less than 300 undescribed species exist above the timber line. Diptera should eventually surpass Coleoptera and prove to be the most abundant of nival insects. Except Collembola, the remaining orders represent minor taxonomic elements of the nival insect fauna.

The distribution and zoogeographical analysis of the different orders of nival insects are discussed below.

PLECOPTERA

Although several species of stoneflies are widely distributed, often at great elevations and close to the permanent snow line (100), throughout the NW. Himalaya, a relatively small number of species has so far been identified and described. Among the species listed below endemism is high, viz. 80%. They are localized in the drainage area of the Chenab-Beas system. The species belong to well-known Holarctic genera of Tertiary origin. We do not at present know anything about the Plecoptera of the mountain ranges drained by the Indus.

Nemouridae

*1. **Capnia manii** Jewett
Localities : Beas Valley, near Marhi 3352 m., Marhi 3657 m.

*2. **Nemoura (Nemoura) cordata** Jewett
Localities : Gramphu 3352 m., Chandra Valley 3352-3657 m.

*3. **Nemoura (Nemoura) punctata** Jewett
Localities : Gramphu 3657 m., Beas Valley near Marhi 3352 m.

*4. **Nemoura (Nemoura) punjabensis** Jewett
Localities : Chhatru 3352-3657 m., Rahla 2743 m., in Beas 3.5 km. below Rahla 3048-3352 m., Kulti Nal 3535 m., Gramphu 3657 m., Dhorni 3657 m., Pir Panjal Range opposite Kulti Nal 3657 m., Rohtang Pass 3962 m.

5. **Rhabdiopteryz lunata** Kimmins
Localities : Kulti Nal 3535 m., Chhatru 3500 m., Hamta Jot 4420 m., Kulu Valley.
Other Distribution : Rongbuk (Tibet) 5028 m., Everest Base Camp, Rongbuk Glacier.

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*Throughout this paper the species marked with an asterisk are endemites.

ODONATA

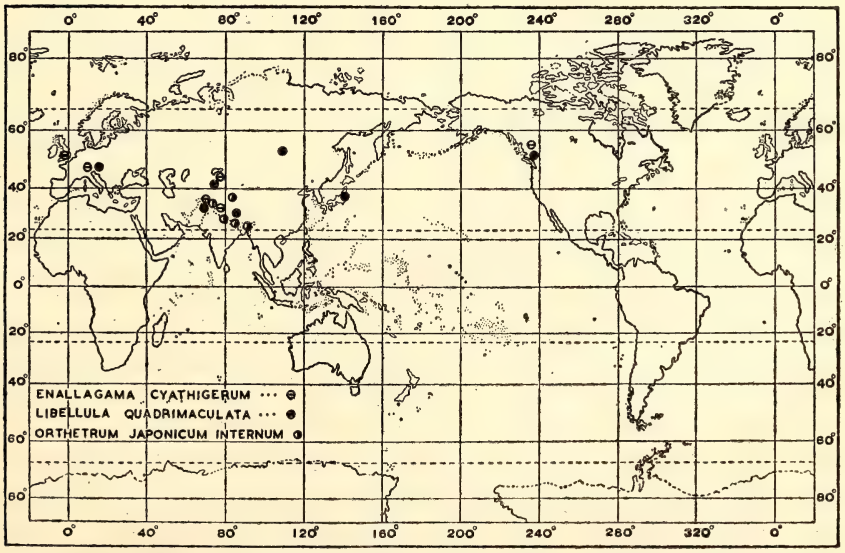
Though our knowledge of this order occurring in the region is at present very incomplete, there seems to be little doubt that the dragonflies are unimportant minor elements in the nival insect fauna of the north-west Himalaya. As may be expected, endemism is rather very low. All the known species seem to be localized in the drainage areas of Jhelum and Chenab-Beas. Outside the NW. Himalaya, they are widely distributed in the Holarctic Realm (Fig. 4). As explained in our paper on the field ecology of the nival insects (100), the specializations of the Odonata do not seem to harmonize with the general ecologic conditions in the biome of the montane tundra of the NW. Himalaya.

Coenagriidae

1. **Enallagama cyathegerum** Charp.
   Localities : Kashmir 3000 m.
   Other Distribution : Central Asia, Tibet, Europe, N. America.

Libellulidae

2. **Libellula quadrimaculata** Linn.
   Localities : Yusimarg 3040 m., Gulmarg.
   Other Distribution : Lahsa, Europe, Central and N. Asia, Japan, N. America.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ENALLAGAMA CYATHIGERUM ··· ⊖
LIBELLULA QUADRIMACULATA ··· ●
ORTHETRUM JAPONICUM INTERNUM ◑

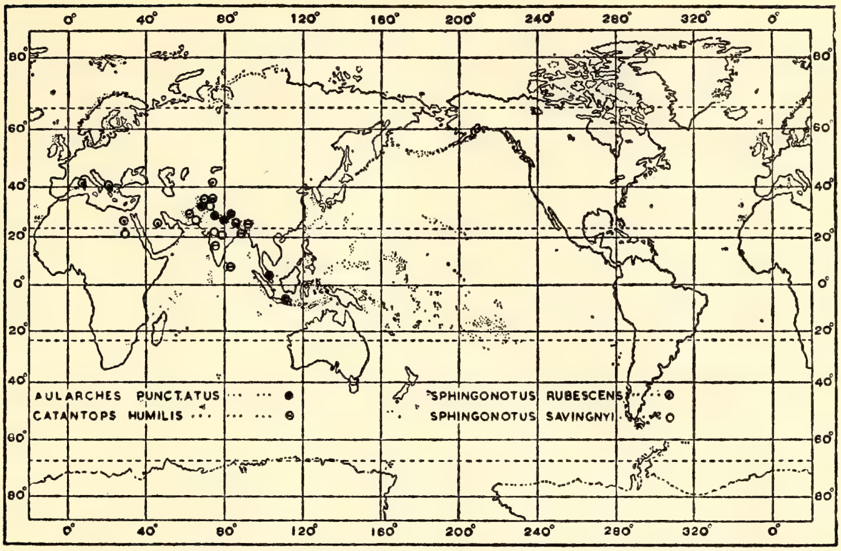
Fig. 4. The world distribution of the non-endemic nival Odonata from the north-west Himalaya.

3. **Orthetrum japonicum internum** MacLach.
   Localities : Kashmir 3000 m.
   Other Distribution : The Himalayan districts of Bengal, Nepal, Tibet, SW China, Assam.

*4. **Sympatrum tandicola** Santokh
   Localities : Upper Chenab Valley near Tandi 3352 m.

ORTHOPTERA

This order constitutes about 3.3% of the total nival insect fauna (Table I, fig. 3) and comprises mostly Acrididae. Nearly 71% of the species are endemic. The Palaearctic elements constitute about 85.5% (Table X). There are several Mediterranean forms like *Sphingonotus* and *Oedipoda.* The central Asian elements are represented by four species of *Gomphomastax*, a genus which Uvarov (151) believes to have derived from ancient tropical and subtropical Eumastacinae. *Sphingonotus rubescens* (Walk.) (Fig. 5) is also known from Pamir, Persia, Baluchistan, Arabia, Palestine, Egypt, Lebanon, Sahara, Greece, Sardinia, and Canary Islands. Outside the NW. Himalaya, *Sphingonotus savingnyi* Sauss. (Fig. 5) occurs also in Sind and N. Africa. The genus *Sphingonotus* does not seem to inhabit very high elevations. *Metrioptera* is also common in Pamir, Alai, and other Turkestan mountains. *Bryodema luctuosa* (Stoll.) is an endemic species, but the genus *Bryodema* is known from Mongol-Tibetan border mountains and represents the Manchurian or the east-Asian South Palaearctic component of the nival insects of the region. *Conophyma mitchelli* Uvarov is an extremely interesting endemite. The genus *Conophyma* is also a central Asian form, with 13 species from Pamir (106) and other neighbouring Turkestan mountains (Fig. 6). Two other endemic species, *Dicranophyma hingstoni* Uvarov and *D. babaulti* Uvarov, also often occur near the timber line on the north slopes of the Great Himalaya in the Nanga Parbat area and seem to represent ecologically transitional forms. It must be observed that the genus *Dicranophyma* is itself endemic. The Indo-Malayan element is represented by *Aularches punctatus* (Drury) (Fig. 5), which often occurs at elevations of nearly 4800 m. above m.s.l. Though the great bulk of the species of Orthoptera from the NW. Himalaya seem to be generally localized at elevations of about 3500 m., the maximum altitudinal record of 5000 m. above m.s.l. is reached by the Tettigonid *Hyphinomus fasciata* Uvarov. The majority of the Palaearctic species, especially the central Asian forms, are generally localized north of the main crest line of the Great Himalaya Range and the Mediterranean forms are similarly mostly localized in areas to the south of this crest line. The zoogeography of some of the more common high altitude Orthoptera from the NW. Himalaya has recently been discussed by Uvarov in a series of short papers (146-157).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AULARCHES PUNCTATUS ... ●
CATANTOPS HUMILIS ... ⊖
SPHINGONOTUS RUBESCENS ... ⊗
SPHINGONOTUS SAVINGNYI ... ○

Fig. 5. The world distribution of the non-endemic nival Orthoptera from the north-west Himalaya.

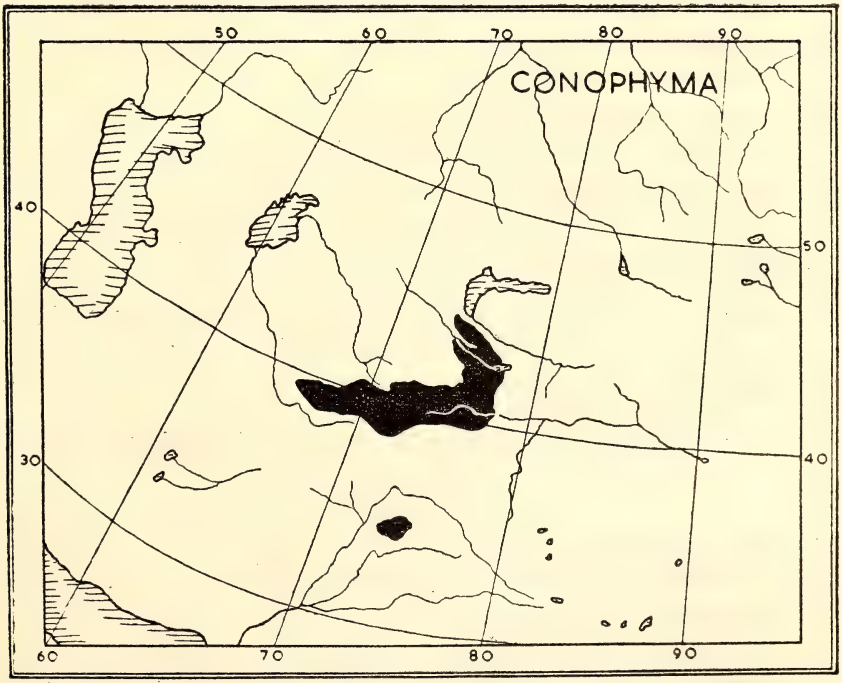
CONOPHYMA
50 60 70 80 90
40 30
50 40
60 70 80 90

Fig. 6. The area of endemism (shaded black) of *Conophyma*, comprising central Asia and the north-west Himalaya.

Acrididae

1. **Aularches punctatus** (Drury)
Localities : Kashmir, about 3000 m.
Other Distribution : Tibet, Nepal, Garhwal, Malaya, Java.

*2. **Bryodema luctuosa** (Stoll.)[1]
Localities : Tso-Morari 4520 m.

3. **Catantops humilis** (Serville)
Localities : Spiti, Gharry, about 300 m.
Other Distribution : Sikkim, Assam, Calcutta, Bombay, Ceylon.

*4. **Conophyma mitchelli** Uvarov
Localities : Srinagar 3350-3960 m.

*5. **Dicranophyma hingstoni** Uvarov
Localities : Astor District about 3000 m.

*6. **Dicranophyma babaulti** Uvarov
Localities : Gond about 3000 m.

*7. **Gomphomastax bolivari** Uvarov
Localities : Tragbal Pass 3200 m.

*8. **Gomphomastax antennatus** Brunner
Localities : Tragbal Pass 3200 m.

*9. **Gomphomastax disparilis** Uvarov
Localities : Tragbal Pass 3200 m.

*10. **Gomphomastax** sp.
Localities : Tso-Morari 4540 m.

*11. **Oedipoda himalayana** Uvarov
Localities : Doyan 2440 m., Mulbek 4420 m.

*12. **Spathosternum prasiniferum** (Walker)
Localities : Tragbal Pass 3200 m.

13. **Sphingonotus rubescens** (Walker)
Localities : Leh, 3440 m.
Other Distribution : Baluchistan, Arabia, Persia, Palestine, Lebanon, Egypt, Sahara, Greece, Sardinia, Canary Is., and Pamir.

14. **Sphingonotus savingnyi** Sauss.
Localities : Ladakh 3500 m.
Other Distribution : Sind, central and western India, North Africa.

Tettigonidae

*15. **Hyphinomus fasciata** Uvarov
Localities : Dakar (Ladakh-Tibet border) 4572-4876 m.

*16. **Metrioptera** sp.
Localities : Tragbal Pass 3200 m.

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[1] *Bryodema inda* Sauss. is recorded from Dakar on Tibet border. We have not seen specimens of this species and, in the absence of fuller data, we are not including this species here.

DERMAPTERA

This order is represented by three species of the typically Palaearctic genus *Anechura*, belonging to the mountain-inhabiting Anechurinae. The genus *Anechura* occurs in N. and central Asia and Europe. *Anechura zubovskii* Sem. occurs north of the main crest line of the Great Himalaya in the area drained by River Indus and the remaining two species seem to be localized in the areas south of the crest line in the Chenab-Beas drainage slopes. According to Burr (17), *Anechura zubovskii* Sem. is a local subspecies of *Anechura bipunctata* Sem., the typical form of which is known from Pyrenees, Alps, and the Balkan Mountains. In Crimea, Persia, and the Caucasus the subspecies *orientalis* seems to be common, *Anechura zubovskii* Sem. is also known from western parts of Tibet.

Forficulidae

*1. **Anechura bipunctata pirpunjalae** Santokh
Localities : Khoksar 3657 m., Marhi 3657 m., Kulti Nal 3530 m., Hamta Jot 4440 m.

*2. **Anechura himalayana** Santokh
Localities : Khoksar 3657 m., Marhi 3657 m., Rahla 2745 m.

*3. **Anechura zubovskii** Semenov
Localities : Ladakh, Kashmir, 3500 m., road from Srinagar to Gilgit.

HETEROPTERA

This order constitutes about 4.5% of the total nival insect fauna of the region (Table I, fig. 5) and comprises mostly Lygaeidae. The species endemism amounts to nearly 65% and there are also two endemic genera *Dolmacoris* Hutchinson and *Tibetocoris* Hutchinson. The Palaearctic elements constitute nearly 94% and are largely represented by central Asian and North Palaearctic forms (Table X). *Bianchiella adelungi* Reut. represents the Manchurian element of the nival Heteroptera from the region. *Lamprodema brevicollis* Fieb., known from Dalmatia (Europe), appears to contribute the Mediterranean element (Fig. 7). The distribution of *Microplax hissarensis* Kiritsch. is shown in Fig. 7. *Nysius ericae* (Schill.), found commonly in the high elevations of the NW. Himalaya, is also known to occur in Pamir, Alai mountains, Astrakhan, Turkestan mountains, Taurus mountains, central Russia, Algeria, mountains of Yugoslavia, Rumania, Hungary, Austria, Switzerland, Belgium, and Germany (Fig. 8). The genus *Nysius* is widely distributed (Fig. 9) in Pamir and other Turkestan mountains, central Asiatic mountains, Mongolia, Japan, Mt. Everest area of the Himalaya, Greenland, Alaska, Egypt, Caucasus, Alps, Pyrenees, Syria, Canary Islands, Germany, France, Belgium, Holland, Hungary, Lapland, and Leningrad area.

The pentatomid *Phimodera rupshuensis* Hutchinson, occurring at an elevation of 4520 m. above m.s.l., is an interesting endemic. The genus *Phimodera* is widely distributed (Fig. 10) in central and N. Asia and in Europe. *Chlamydatus pachycerus* Kiritsch. is an interesting species which has been reported from the Mt. Everest area in the E. Himalaya. The genus is distributed (Fig. 11) in Caucasus, Siberia, Mongolia, Alaska, Greenland, Canada, Europe, and Algeria. The only Indo-Malayan form is the apterous Aradidae *Brachyrhynchus tagalicus* (Stoll.), confined to the birch-juniper zone at the edge of the taiga on the Pir Panjal Range, in the area drained by Chenab-Beas system. This species is ecologically and geographically a transitional form.

Four of the species are confined to an elevation of 3500 m. above m.s.l. and five each above 4000 m. and 5000 m. *Nysius ericae* (Schill.) occurs from an elevation of 3500 m. to nearly 5200 m. and *Nysius ericae alticola* Hutchinson occurs as high as 5365 m., which at present represents the maximum altitude record for Heteroptera in the NW. Himalaya.

Nearly 94% of the known species are localized in the area drained by River Indus, north of the crest line of the Great Himalaya.

Some of the peculiarities of the distribution of the high altitude Heteroptera from the NW. Himalaya and the neighbouring regions are discussed by Hutchinson (74), Oshanin (114), Kiritschenko (78, 79), and Reinig (123).

Pentatomidae

*1. **Phimodera rupshuensis** Hutchinson
Localities : Peldo la near north end of Tso-Morari 4520 m.

Coreidae

*2. **Stictopleura** sp.
Localities: Tsak-Shang and Tsak-ra, road from Tso-Morari to Tso-Kar 4570 m.

Lygaeidae

3. **Bianchiella adelungi** Reuter
Localities : Igu in the Indus Valley above Leh, 3400 m.
Other Distribution : North China, Mongolia, Siberia.

*4. **Dolmacoris deterrana** Hutchinson
Localities : Nying-ri and Chungang La, 5120-5180 m.

*5. **Emblethis horvathiana** Hutchinson
Localities : Renka-la 5580 m., between Mitpal-Tso and Yaye Tso.

6. **Lamprodema brevicollis** Fieb.
Localities : Tanktze to Chagra, Pongong Valley 4270 m., Ladakh.
Other Distribution : Dalmatia (Europe).

7. **Nysius ericae** (Schill.)
   Localities : Leh 3440 m., Tsak-shang north of Tso-Morari 4570 m., Kayam La 4880 m., Koh Lungpa Valley 4880 m., Renka La between Mitpal Tso and Naye Tso 5180 m., and Ororotse Tso.
   Other Distribution : Central Asia, Pamir.

*8. **Nysius ericae alticola** Hutchinson
   Localities : Ororotse Tso 5280 m., Kyang La 5000-5300 m.

9. **Microplax hissarensis** Kiritschenko
   Localities : Between Tsak-shang and Tsak-ra, road from Mitpal Tso to Tso Kar 4572 m.
   Other Distribution : North Bukhara.

Aradidae

10. **Brachyrhynchus tagalicus** (Stoll.)
   Localities : Pir Panjal Range, Chandra Valley near Gramphu 3657 m.
   Other Distribution : Burma, Java, Philippines.

Anthocoridae

*11. **Anthocoris gyalpo** Hutchinson
   Localities : Leh 3500 m.

*12. **Ectemnus paradoxus** Hutchinson
   Localities : Igu in Indus Valley above Leh 3500 m.

Miridae

*13. **Chlamydatus pachycerus** Kiritschenko
   Localities : Shakya La 5180 m., Kyang La 5120-5330 m., Ororotse Tso 5300 m. Marsimik La 5300 m., Kyam La 4730 m., Nyangtzu 4660 m., Paldo La north of Tso Morari 4520 m., Tsak-Shang.
   Other Distribution : Southern Tibet; Mt. Everest area Eastern Himalaya 4110-5030 m.

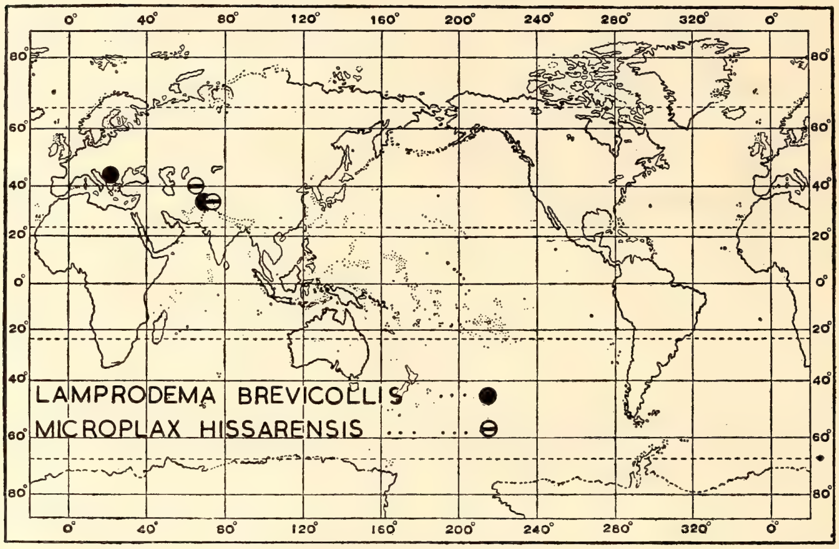
*14. **Dicyphus physochlaenae** Hutchinson
   Localities : Damb Guru 4620 m.

15. **Dicyphus senggae** Hutchinson
   Localities : Between Tankse and Mugleb 4175 m.

*16. **Tibetocoris margaretae** Hutchinson
   Localities : Chang Chenmo near Pamzal 5180-5270 m., Nying-ri 5120 m., Chungang La 5300 m., Kakstet La 5365 m.

Saldidae

*17. **Chiloxanthus alticola** Kiritschenko
   Localities : Bulaki-Murghai between Depsang and Tshangtsha, Shyok 4255 m.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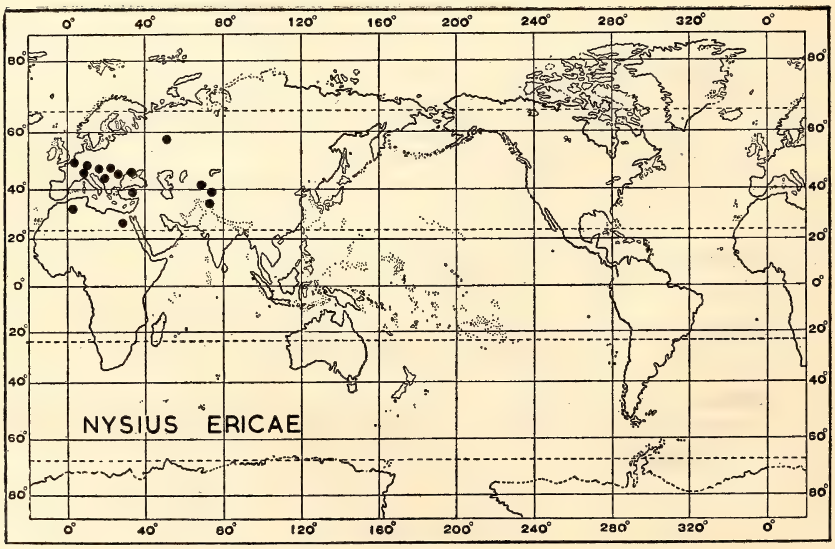
80° 60° 40° 20° 0° 20° 40° 60° 80°
LAMPRODEMA BREVICOLLIS ..... ●
MICROPLAX HISSARENSIS ..... ⊖

Fig. 7. The world distribution of two non-endemic nival species of Heteroptera from the north-west Himalaya.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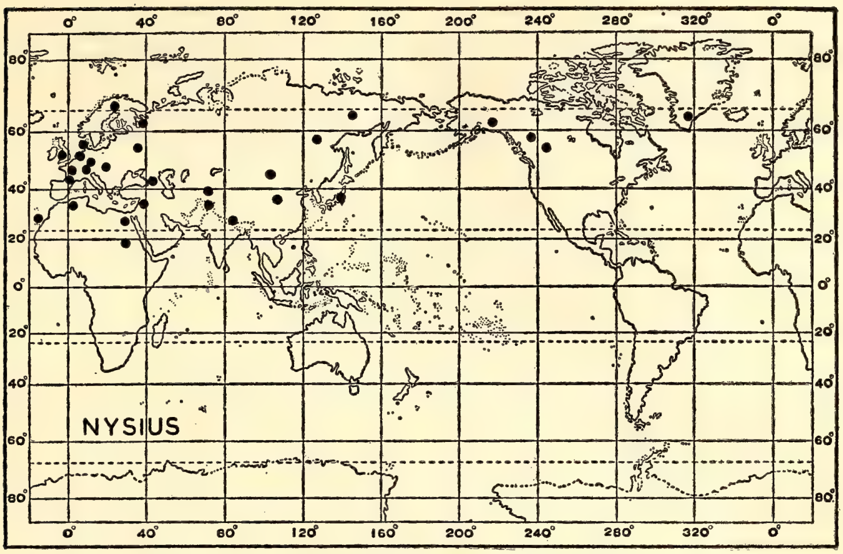
NYSIUS ERICAE

Fig. 8. The world distribution of *Nysius ericae* (Schill.)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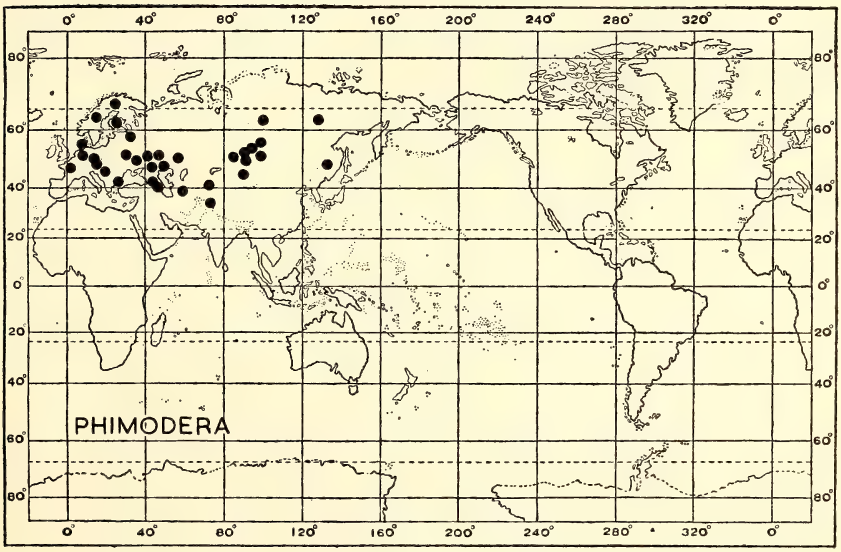
NYSIUS

Fig. 9. The world distribution of the genus *Nysius*.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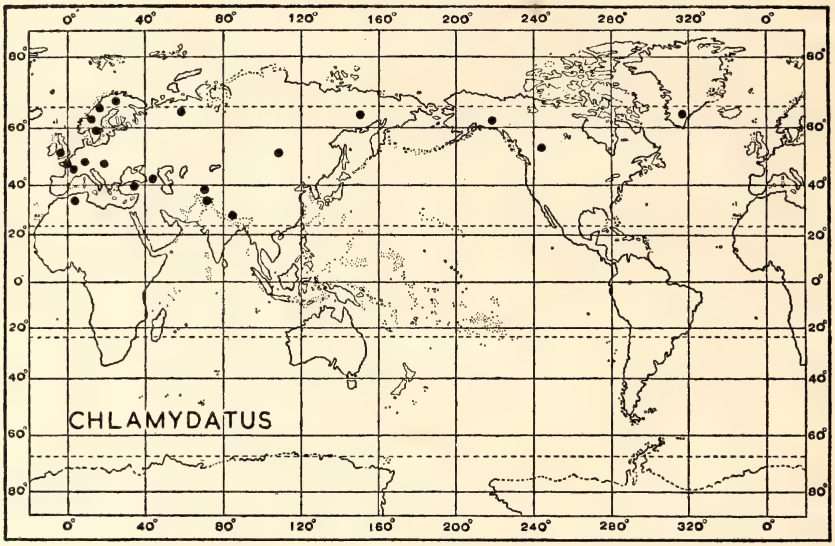
PHIMODERA

Fig. 10. The world distribution of the genus *Phimodera*.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CHLAMYDATUS

Fig. 11. The world distribution of the genus *Chlamydatus*.

HOMOPTERA

This order is represented by *Poophilus costalis* (Walk.) (Cercopidae). It is a widely distributed species found in other parts of Himalaya, Calcutta, Bombay, Karachi, Ceylon, Singapore, S. and W. Africa. In the NW. Himalaya the species has been collected from Dras 3100 m., Kargil 2740 m., and Leh 3440 m.

(*To be continued*)

The Flora of Parlakimedi and its immediate Neighbourhood

PART II

BY

K. S. SRINIVASAN AND G. V. SUBBA RAO
Industrial Section, Indian Museum, Calcutta

[*Continued from Vol.* **58** (1) : 170]

COMPOSITAE

Vernonia cinerea Less.
Parlakimedi.

Elephantopus scaber Linn.
Parlakimedi.

Grangea maderaspatana Poir.
Parlakimedi.

***Ifloga** sp. (Only one species reported by *Hooker* from Upper Gangetic Plains—*Ifloga fontanesii* Cass.)
Parlakimedi.

Blainvillea sp. (Only one species *rhomboidea* Cass. was reported by *Hooker & Gamble*)
Parlakimedi.

Bidens pilosa Linn.
Parlakimedi : in rocky jungles near the top of the hill. *Burkill, Grant & Candler* 20477, Sept. 1903.

Glossogyne pinnatifida DC.
Patapatnam : rare. *Burkill* 20500, Sept. 1903.

Tridax procumbens Linn.
Parlakimedi : very common.

CAMPANULACEAE

***Campanula canescens** Wall.
A weed in the crops of millets etc.
Devagiri, Parlakimedi. *Burkill* 17968, Dec. 1902.

PLUMBAGINACEAE

Plumbago zeylanica Linn.
Peddalogidi, *Burkill, Grant & Candler* 20587, Sept. 1903.

MYRSINACEAE

***Ardisia humilis** Vahl.

Vern. Bontu (S.)
Parlakimedi. *Corey* 20150, 1903.

SAPOTACEAE

Madhuca indica Gmel. (*Bassia latifolia* Roxb.)

Vern. Aba (S.) ; Ippa chettu (T.)
Parlakimedi. *Burkill, Grant & Candler* 20525, Sept. 1903. 610 m. *Corey & Ramamurthy* 20112, Sept. 1903.

EBENACEAE

Maba buxifolia Pers.

Parlakimedi : in sandy areas in low hill jungles. *Burkill, Grant & Candler* 20425, Sept. 1903.

Diospyros tomentosa Roxb.

Parlakimedi : in jungles in valleys. *Burkill, Grant & Candler* 20527, Sept. 1903.

APOCYNACEAE

Carissa spinarum A.DC.

Parlakimedi : on sandy strips. *Burkill, Grant & Candler* 20527, Sept. 1903.

Thevetia peruviana (Pers.) Schum. (*Thevetia nereifolia* Juss. ex Steud.)

Parlakimedi : planted.

***Rauvolfia canescens** Linn.

Parlakimedi : in jungles in the valleys. *Burkill, Grant & Candler* 20550, Sept. 1903.

***Alstonia neriifolia** Don.

Parlakimedi : in rocky jungles. *Burkill & Candler* 17986, Dec. 1902 ; *Burkill Grant & Candler* 20485, 20572, Sept. 1903.

Holarrhena antidysenterica Wall.

Parlakimedi : abundant in low jungles. *Burkill, Grant & Candler* 20493, 20566, 20567, Sept. 1903.

ASCLEPIADACEAE

Hemidesmus indicus R. Br.

Vern. Eriji (S.) ; Sugandhu chettu (T.)
Parlakimedi : 915 m. *Burkill* 20132, Sept. 1903.

***Cryptolepis grandiflora** Wight

Parlakimedi. *Burkill & Candler* 17987, Dec. 1902.

Cryptolepis elegans Wall.

Parlakimedi. *Burkill, Grant & Candler* 20430, Sept. 1903.

Calotropis procera Br.

Parlakimedi. *Burkill, Grant & Candler* 20554, Sept. 1903.

Pergularia daemia (Forsk.) Chiov. (*Daemia extensa* R. Br.)

Parlakimedi: common in the valleys. *Burkill, Grant & Candler* 20546, Sept. 1903.

***Tylophora pauciflora** W. & A.

Ramasagaram : on the bund. *Burkill, Grant & Candler* 20535, Sept. 1903.

Ceropegia tuberosa Roxb.

Parlakimedi : in low jungles. *Burkill & Candler* 20402. Sept. 1903.

Caralluma adscendens Br.

Parlakimedi : very common among rubble. *Burkill* 20499, Sept. 1903.

GENTIANACEAE

Canscora decussata Roem. & Sch.

Devagiri : in thin jungles. *Burkill & Candler* 17936, Dec. 1902.

BORAGINACEAE

* **Cordia myxa** Linn.

Vern. Bari (S.) ; Nakkare chettu (T.)
Parlakimedi. *Corey* 20173, 1903.

Ehretia microphylla Lamk. (*Ehretia buxifolia* Roxb.)

Parlakimedi : very common. *Burkill, Candler & Grant* 20495, Sept. 1903.

Trichodesma indicum Br.

Parlakimedi.

CONVOLVULACEAE

Evolvulus alsinoides Linn.

Parlakimedi : chiefly in sandy places at the foot of hills. *Burkill, Grant & Candler* 20419, Sept. 1903.

Erycibe paniculata Roxb.

Parlakimedi : in low jungles. *Burkill, Grant & Candler* 20433, Sept. 1903.

* **Merremia gemella** (Burm. f.) Hall. f. (*Ipomoea polyantha* Miq.)

Parlakimedi. *Burkill, Grant & Candler* 20474, Sept. 1903.

Merremia tridentata (Linn.) Hall. f. (*Ipomoea tridentata* Roth.)

Parlakimedi : at the bottom of valleys. *Burkill & Candler* 18106, Dec. 1902.

Operculina turpethum (Linn.) Silva-Manso. (*Ipomoea turpethum* Br.)

Vern. Tampatada (S.) ; Arategadi chettu (T.)
Parlakimedi : 30.m. *Corey & Ramamurthy* 20186, Sept. 1903.

* **Argyreia choisyana** Wight

Parlakimedi : in the Sal forests in the valleys and also in low jungles. *Burkill, Grant & Candler* 20514, Sept. 1903.

SOLANACEAE

* **Solanum indicum** Linn.

Vern. Jiddumunaga chettu (T.)
Parlakimedi. *Corey & Ramamurthy* 20135, Sept. 1903.

Solanum melongena Linn. (Wild form)

Vern. Andarai (S.) ; Kondavankaya chettu (T.)

Parlakimedi : in valleys at lower levels and roadsides. *Burkill* 18105, Dec. 1902 ; *Burkill, Grant & Candler* 20534, Sept. 1903 ; 915 m. *Corey & Ramamurthy* 20133, Sept. 1903.

Solanum xanthocarpum Schrad. & Wendl.

Parlakimedi. *Burkill, Grant & Candler* 20579, Sept. 1903.

***Capsicum minimum** Roxb.

Parlakimedi, Devagiri : in cultivated patches ; 915 m. *Burkill* 17981, Dec. 1902.

Datura metel Linn. (*Datura fastuosa* Linn.)

Parlakimedi : in valleys near dwellings. *Burkill, Grant & Candler* 20545, Sept. 1903.

SCROPHULARIACEAE

Mazus japonicus (Thunb.) Kuntze. (*Mazus rugosus* Lour.)

Parlakimedi.

***Lindenbergia indica** (Linn.) O. Kuntze. (*Lindenbergia polyantha* Royle)

Parlakimedi, Devagiri. *Burkill & Candler* 17956, Dec. 1902.

Scoparia dulcis Linn.

Parlakimedi : common on bunds in sandy soils and near river courses. *Burkill* 17999, Dec. 1902. *Burkill, Grant & Candler* 20504, Sept. 1903.

***Melasma avense** (Benth.) Pennell. (*Alectra indica* Benth.)

Parlakimedi, Devagiri : a weed in millet fields. 915 m. *Burkill & Candler* 17970, Dec. 1902.

Centranthera humifusa Wall.

Parlakimedi : in boggy sandy places and edges of ragi fields, also in glades in valleys. *Burkill, Grant & Candler* 20521, Sept. 1903.

LENTIBULARIACEAE

Utricularia flexuosa Vahl.

Parlakimedi : in tanks with Nymphaeas. *Burkill, Grant & Candler* 20508, Oct. 1903.

BIGNONIACEAE

Kigelia pinnata DC.

Parlakimedi : planted.

***Tabebuia pentaphylla** Hemsl.

Parlakimedi : planted. *Burkill, Grant & Candler* 20557, Sept. 1903.

Oroxylum indicum Vent.

Vern. Pampena (S) ; Pampena chettu, Konda pampena chettu (T.)

Parlakimedi. *Corey & Ramamurthy* 20196, Sept. 1903.

PEDALIACEAE

Pedalium murex Linn.

Parlakimedi: in sandy roadsides. *Burkill, Grant & Candler* 20506, Sept. 1903.

Sesamum indicum DC.
Parlakimedi. *Burkill* 18104, Dec. 1902.

MARTYNIACEAE

Martynia annua Linn. (*Martynia diandra* Glox.)

Vern. Kinakarsi (S.) ; Puligoru chettu (T.)
Parlakimedi: at higher elevations up to 915 m. *Corey & Ramamurthy* 20122, Sept. 1903.

ACANTHACEAE

Elytraria acaulis (Linn. f.) Lindau. (*Elytraria crenata* Vahl.)
Parlakimedi.

Asteracantha longifolia Nees
Parlakimedi.

Dipteracanthus prostratus (Poir.) Nees. (*Ruellia prostrata* Poir.)
Parlakimedi: common everywhere. *Burkill & Candler* 20403, Sept. 1903.

***Hemigraphis elegans** Nees

Parlakimedi, Devagiri: in lower parts of jungles. *Burkill & Candler* 17935, 17943, Dec. 1902.

Blepharis maderaspatensis (Linn.) Heyne ex Roth. (*Blepharis boerhaviaefolia* Pers.)

Parlakimedi: in rocky hill jungles. *Burkill, Grant & Candler* 20476, Sept. 1903 ; *Burkill & Candler* 17994, Dec. 1902.

Blepharis molluginifolia Pers.

Parlakimedi: on dry rubble. *Burkill, Grant & Candler* 20494, Sept. 1903.

Barleria prionitis Linn.

Vern. Tamresa (S.) ; Mulugorinta chettu (T.)
Parlakimedi. *Burkill, Grant & Candler* 20552, 30 m. Sept. 1903 ; *Corey & Ramamurthy* 20162, 1903.

Barleria strigosa Willd.

Parlakimedi, Devagiri: in dense shade and by streams. *Burkill & Candler* 17973, Dec. 1902 ; *Burkill, Grant & Candler* 20461, Sept. 1903.

***Asystasia chelonoides** Nees var. **amoena** Kurz.

Parlakimedi. *Burkill & Candler* 17995, Dec. 1902.

Andrographis paniculata Nees

Vern. Resan (S.) ; Nelavembu chettu (T.)
Parlakimedi. *Burkill* 17926, Dec. 1902, 305 m. *Corey & Ramamurthy* 20141, Sept. 1903.

Lepidagathis fasciculata Nees

Parlakimedi. *Burkill & Candler* 17921, Dec. 1902.

Justicia betonica Linn.

Parlakimedi : among *Holarrhena* bushes. *Burkill, Grant & Candler* 20503, Sept. 1903.

Justicia glauca Rottl.

Parlakimedi : plenty in low jungles *Burkill, Grant & Candler* 20437, Sept. 1903.

Rungia repens (Linn.) Nees. (*Justicia repens* Linn.)

Parlakimedi.

***Dicliptera beddomei** Clarke

Parlakimedi : in hill jungles, plenty. *Burkill, Grant & Candler* 20467, Sept. 1903.

LABIATEAE

Orthosiphon pallidus Royle

Parlakimedi : on roadsides, sandy places and embankments. *Burkill, Grant & Candler* 20501, Oct. 1903.

Anisochilus carnosus Wall.

Parlakimedi. *Burkill, Grant & Candler* 20415, Sept. 1903.

Dysophylla quadrifolia Benth.

Parlakimedi. *Burkill & Candler* 17996, Dec. 1902 ; *Burkill, Grant & Candler* 20563, Sept. 1903.

***Leucas mollissima** Wall. var. **strigosa** Hook. f.

Parlakimedi : in low jungles. *Burkill, Grant & Candler* 20432, Sept. 1903.

Leucas cephalotes Spreng.

Parlakimedi : fairly common in sandy fields. *Burkill, Grant & Candler* 20558, Oct. 1903.

Leucas aspera Spreng.

Parlakimedi.

AMARANTHACEAE

Celosia argentea Linn.

Parlakimedi: in ragi fields and sandy roadsides. *Burkill, Grant & Candler* 20537, Sept. 1903.

Allmania nodiflora Br.

Parlakimedi. *Burkill, Grant & Candler* 20412, Sept. 1903.

***Allmania nodiflora** Br. var. **procumbens** Hook. f.

Parlakimedi. *Burkill, Candler & Grant* 20541, Sept. 1903.

Amaranthus spinosus Linn.

Parlakimedi.

Aerva javanica (Burm. f.) Spreng. (*Aerva javanica* Juss.)

Parlakimedi.

ARISTOLOCHIACEAE

Aristolochia indica Linn.
Vern. Son (S.) ; Nagasara (T.)
Parlakimedi : 30 m. *Corey* 20178, 1903.

PIPERACEAE

* **Peperomia pellucida** H.B.K.
Parlakimedi. *Burkill, Grant & Candler* 20580, Sept. 1903.

LAURACEAE

Litsaea glutinosa (Lour.) C. B. Robinson (*Litsaea sebifera* Pers.)
Parlakimedi : in hill jungles. *Burkill, Grant & Candler* 20441, Sept. 1903.

VERBENACEAE

Lantana camara Linn.
Parlakimedi.

Stachytarpheta sp.
Parlakimedi.

Tectona grandis Linn. f.
Parlakimedi : planted.

Premna latifolia Roxb.
Vern. Orbonda (S.) ; Peddanelli chettu (T.)
Parlakimedi : 915 m. *Burkill* 20131, 20139, Sept. 1903.

Gmelina asiatica Linn.
Vern. Nalla gummudu chettu (T.)
Parlakimedi : 30 m. *Corey* 20188, Sept. 1903.

Vitex trifolia Linn. f.
Vern. Vayila (S.) ; Vayitaku chettu (T.)
Parlakimedi : 30 m. *Corey* 20167, Sept. 1903.

Vitex pubescens Vahl
Parlakimedi. *Burkill, Grant & Candler* 20519, Sept. 1903.

LORANTHACEAE

Dendrophthöe falcata (Linn. f.) Ettingsh. (*Loranthus longiflorus* Desr.)
Host : *Zizyphus incurva* Roxb.
Devagiri. *Burkill & Candler* 17977, Dec. 1902.

* **Scurrula philippensis** (Cham. & Schlecht.) G. Don. Host : *Emblica officinalis* Gaertn. & *Randia brandisii* Gamble.
Devagiri : 183 m. *Burkill & Candler* 17931, Dec. 1902,
Parlakimedi. *Burkill, Candler & Grant* 20469, Sept. 1903.

Viscum orientale Willd. Host : *Pavetta indica* Linn.
Parlakimedi. *Burkill, Candler & Grant* 20442, Sept. 1903.

EUPHORBIACEAE

Euphorbia hirta Linn. (*Euphorbia pilulifera* Linn.)

Parlakimedi.

Bridelia retusa Spreng.

Parlakimedi ; in low jungles. *Burkill & Candler* 17992, Dec. 1902.

Bridelia tomentosa Bl.

Parlakimedi : common in low jungles. *Burkill, Grant & Candler* 20533, Sept. 1903 ; 20456, Sept. 1903.

Cleistanthus collinus Benth.

Vern. Karada (S.) ; Odise chettu (T.)

Parlakimedi : very common in the valleys in places where Sāl is not present. *Burkill & Candler* 17990, Dec. 1902 ; *Burkill, Grant & Candler* 20516, Sept. 1903 ; 609 m. *Corey & Ramamurthy* 20102, Sept. 1903.

Emblica officinalis Gaertn. (*Phyllanthus emblica* Linn.)

Vern. Ener (S.) ; Usirika chettu (T.)

Parlakimedi : 610 m. *Corey & Ramamurthy* 20117, Sept. 1903.

Phyllanthus maderaspatensis Linn.

Parlakimedi : on stony hill sides. *Burkill, Grant & Candler* 20561, Sept. 1903.

* **Glochidion montanum** Thw.

Vern. Kasakodi (S.) ; Torke chettu (T.)

Parlakimedi : 30 m. *Corey & Ramamurthy* 20161, Sept. 1903.

Securinega virosa (Roxb. ex Willd.) Pax & Hoffm. (*Flueggea microcarpa* Bl.)

Vern. Janjan (S.) ; Kondapindi chettu (T.)

Parlakimedi : 305 m. *Corey & Ramamurthy* 20145, Sept. 1903.

Antidesma ghaesembilla Gaertn.

Vern. Oderi (S.) ; Pultem chettu (T.).

Parlakimedi : 30 m. *Corey & Ramamurthy* 20183, Sept. 1903.

Antidesma diandrum Roth.

Parlakimedi : in jungles. *Burkill, Grant & Candler* 20465, Sept. 1903.

***Croton laevifolius** Bl.

Vern. Parta (S.) ; Rana bhedi chettu (T.)

Parlakimedi : 610 m. *Corey & Ramamurthy* 20114, Sept. 1903.

Mallotus philippensis Muell.

Vern. Goso (S.) : Kunkapu chettu (T.)

Parlakimedi. *Corey & Ramamurthy* 20160, Sept. 1903.

Ricinus communis Linn.

Parlakimedi, Devagiri : on the stony hill-side. 2.5 m. *Burkill* 17980, Dec. 1902.
Naupada, Ganjam Dt. Cuttirabad : 2′-3′ high. *Burkill* 17919, Dec. 1902.

Tragia involucrata Linn.

Vern. Janagatar (S.) ; Revatidulagundi chettu (T.).

Parlakimedi : 305 m. *Corey & Ramamurthy* 20144, Sept. 1903.

Sebastiana chamaelea Muell. Arg.

Parlakimedi. *Burkill, Grant & Candler* 20414, Sept. 1903.

MORACEAE

Ficus gibbosa Bl. var. **parasitica** Koen.

Bund of Ramasagaram, Parlakimedi. *Burkill, Candler & Grant* 20555, Sept, 1903.

***Ficus mysorensis** Heyne var. **pubescens** Roth.

Vern. Kambon-tu (S.) ; Kondamarri chettu (T.)
Parlakimedi : 30 m. *Corey & Ramamurthy* 20168, 1903.

Ficus benjamina Linn.

Parlakimedi (after *Lushington*, 2 : 679).

Ficus religiosa Linn.

Bund of Sitasagaram, Parlakimedi.

Ficus bengalensis Linn.

Bund of Sitasagaram, Parlakimedi.

URTICACEAE

Pouzolzia zeylanica (Linn.) Benn. (*Pouzolzia indica* Gaud.)

Parlakimedi. *Burkill, Candler & Grant* 20471, 20484, Sept. 1903.

CASUARINACEAE

Casuarina equisetifolia Forst.

Parlakimedi : planted.

MONOCOTYLEDONS

ZINGIBERACEAE

Globba orixensis Roxb.

Vern. Sanodol, sulli (S.) ; Karupasupu chettu (T.)
Parlakimedi. *Corey & Ramamurthy* 20179, 1903,

HYPOXYDACEAE

Curculigo orchioides Gaertn.

Parlakimedi : abundant in the woods. *Burkill, Candler & Grant* 20509, Sept. 1903.

AGAVEACEAE

Agave veracruz Mill.

Parlakimedi : not common. *Burkill, Candler & Grant* 20420, Sept. 1903.

Agave cantala Roxb.

Parlakimedi : common along the railway line. *Burkill, Candler & Grant* 20421, Sept. 1903.

DIOSCOREACEAE

Dioscorea pentaphylla Linn.

Parlakimedi. *Burkill, Candler & Grant* 20547, Sept. 1903; *Corey* 14511, Oct. 1903.

Dioscorea hispida Dennst. (*Dioscorea daemona* Roxb.)

Parlakimedi.

Dioscorea tomentosa Linn.

Vern. Barogi (S.); Nunetige chettu (T.)
Devagiri: 823 m. *Burkill* 17967, Dec. 1902.
Parlakimedi: common. *Corey* 20171, 1903; *Burkill, Candler & Grant* 20463, Sept. 1903.

Dioscorea bulbifera Linn.

Parlakimedi. *Burkill, Candler & Grant* 20530, Sept. 1903.

Dioscorea oppositifolia Linn.

Parlakimedi. *Corey* 112.
Devagiri: abundant. *Burkill* 17929, 17946, 17954, Dec. 1902.
Parlakimedi. *Burkill* 17991, 17997, Dec. 1902; *Burkill, Candler & Grant* 20470. Sept. 1903.

Dioscorea esculenta Burkill (*Dioscorea aculeata* Linn.)

Parlakimedi: abundant at foot of hills in low jungles. *Burkill* 17984, Dec. 1902; 14957, 1903. *Burkill, Candler & Grant* 20444, 20454, Sept. 1903.

***Dioscorea anguina** Roxb.

Devagiri. *Burkill* 17932, Dec. 1902.
Parlakimedi. *Corey* 14989, 1903; *Burkill, Candler & Grant* 20440, Sept. 1903.

***Dioscorea glabra** Roxb.

Parlakimedi. *Burkill* 17985, 17993, Dec. 1902.

LILIACEAE

Asparagus racemosus Willd.

Parlakimedi. *Burkill, Candler & Grant* 20486, Sept. 1903.

Gloriosa superba Linn.

Parlakimedi. *Burkill, Candler & Grant* 20407, Sept. 1903.

SMILACACEAE

Smilax zeylanica Linn. (*Smilax macrophylla* Roxb.)

Vern. Ratu, Raathume nape (S.); Kondathamara chettu (T.)
Parlakimedi. *Corey* 20174, 1903.

COMMELINACEAE

Commelina nudiflora Linn.

Peddalogidi. *Burkill, Candler & Grant* 20589, Sept. 1903.

Commelina benghalensis Linn.

Parlakimedi. *Burkill, Candler & Grant* 20540, Sept. 1903.

Cyanotis cristata (Linn.) Schultes.

Parlakimedi : among rocks in hill jungle. *Burkill, Candler & Grant* 20482, Sept. 1903.

Cyanotis axillaris Roem. & Sch.

Parlakimedi. *Burkill, Candler & Grant* 20410, Sept. 1903.

PALMAE

Phoenix sylvestris Roxb.

Parlakimedi.

Calamus viminalis Willd.

Vern. Rere (S.) ; Pemu chettu (T.)
Parlakimedi : rattan of low jungles, grows to a height of 6 m., fairly common. *Burkill & Candler* 17988, Dec. 1902. *Corey & Ramamurthy* 20126, 1903.

Cocos nucifera Linn.

Parlakimedi.

Borassus flabellifer Linn. (*Borassus flabelliformis* Murr.)

Parlakimedi.

CYPERACEAE

Cyperus castaneus Willd.

Parlakimedi : on sand. *Burkill, Candler & Grant* 20449, Sept. 1903.

* **Cyperus cuspidatus** H. B. & K. var. **angustifolia** Clarke.

Parlakimedi : on sand. *Burkill, Candler & Grant* 20450, Sept. 1903.

Cyperus rotundus Linn. (*Cyperus tuberosus* Rottb.)

Naupada : on sand. *Burkill, Candler & Grant* 20590, Sept. 1903.

Fimbristylis miliacea Vahl

Parlakimedi : common in sandy swamps. *Burkill, Candler* & Grant 20505, Sept. 1903.

Fimbristylis monostachya Hassk.

Parlakimedi : very common in sandy places. *Burkill, Candler & Grant* 20487, Sept. 1903.

Scleria lithosperma Sw.

Parlakimedi : common. *Burkill, Candler & Grant* 20422, Sept. 1903.

GRAMINEAE

***Saccharum arundinaceum** Retz.

Parlakimedi. *Burkill* (through *Dy. Tehsildar*) 21792, Mar. 1904.

Saccharum arundinaceum Retz. var. **ciliare** Anders.

Vern. Jaya karra (T.)
Parlakimedi. *Burkill* (through *Dy. Tehsildar*) 24071, Feb. 1905.

Sorghum roxburghii Stapf var. **semiclausum** Stapf

Vern. Juar.
Devagiri : cultivated on hill sides. *Burkill* 17920, 17960, Dec. 1902.

Chrysopogon aciculatus (Retz.) Trin. (*Andropogon aciculatus* Retz.)
Parlakimedi.

Hackelochloa granularis (Linn. f.) O. Ktze. (*Manisuris granularis* Linn. f.)
Parlakimedi : in hill jungles growing to a height of 1.5 to 2 m. *Burkill, Candler & Grant* 20473, Sept. 1903.

Digitaria granularis (Trin.) Henr. (*Paspalum pedicellare* Trin. ex Steud.)
Parlakimedi : in sandy places. *Burkill, Candler & Grant* 20543, Sept. 1903.

Brachiaria distachya (Linn.) Stapf. (*Panicum distachyum* Linn.)
Parlakimedi : common in sandy places. *Burkill, Candler & Grant* 20583, Sept. 1903.

Panicum montanum Roxb.
Parlakimedi : common. *Burkill, Candler & Grant* 20436, Sept. 1903.

Setaria italica Beauv.
Parlakimedi.

Pennisetum typhoides (Burm. f.) Stapf. & Hubb. (*Pennisetum typhoideum* Rich.)
Vern. Bajri.
Devagiri : cultivated on hill sides. 30-915 m. *Burkill* 17962, 17969, Dec. 1902.

Eragrostis tenella (Linn.) Beauv. ex Roem. & Schult.
(*Eragrostis tenella* Roem. & Schult. var. *plumosa* Stapf.)
Parlakimedi : on rocky hill side. *Burkill, Candler & Grant* 20488, Sept. 1903.

Eragrostis unioloides (Retz.) Nees. (*Eragrostis amabilis* W. & A.)
Parlakimedi. *Burkill, Candler & Grant* 20491, 20523, Sept. 1903.

Cynodon dactylon Pers.
Parlakimedi. *Burkill, Candler & Grant* 20584, Sept. 1903.

Eleusine coracana Gaertn.
Devagiri : 610-915 m. *Burkill* 17959, Dec. 1902.
Parlakimedi : cultivated. *Burkill, Candler & Grant* 20536, Sept. 1903.

Dactyloctenium aegyptium (Desf.) Beauv. (*Eleusine aegyptiaca* Desf.)
Parlakimedi.

Oryza sativa Linn.
Parlakimedi : wild and abundant (*Burkill*).
Devagiri. *Burkill* 17979, Dec. 1902.

Dendrocalamus strictus Nees
Parlakimedi : hill jungles.

SUMMARY

1. The Flora of Parlakimedi (18°47′ N. and 84°5′ E.) in the South Ganjam District in India is described in detail.

2. The vegetation of the locality under broad ecological groups, as those of sandy areas, low hill jungles, dry broken jungles, dry rocky hill slopes, valleys, at different altitudes, river-sides, is described in detail.

3. The total number of species listed from Parlakimedi is 286 under 229 genera and 75 families.

4. 45 species are reported as new to Ganjam District.

5. A new host report for *Dendrophthöe falcata* (Linn. f.) Ettingsh. is recorded.

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A Review of some Grass-infesting Thrips from India with a Description of a New Species

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Plants of the families Gramineae and Cyperaceae have been known to harbour a wealth of Thrips fauna. But for records from random collections, no precise information is available in this country of the thrips infesting Gramineae, though an early attempt towards such a study was made by Ananthakrishnan (1956)[1] on *Andropogon pertusus.* Several species of Gramineae were subsequently examined, including *Apluda aristata*, *Chloris barbata*, *Cynodon dactylon*, *Cymbopogon citratus*, *Eragrostis* sp., *Oryza sativa*, *Panicum maximum*, *Sorghum vulgare.*

While it is natural to classify the graminivorous thrips as leaf sheath, leaf blade, and inflorescence inhabitants, the degree of infestation is of importance, particularly when it is observed that many grasses harbour several species of thrips, some primary inhabitants, others secondary, yet others casual or rare, with the possibility of being accidentally carried by wind or other factors. For instance, in *Andropogon pertusus*, Ananthakrishnan (1956) has recorded a large percentage of *Podothrips oryzae* Priesner and *Neolimothrips saccharivora* Shumsher, moderate numbers of *Anaphothrips flavicinctus* Karny, *Phibalothrips peringueyi* Faure, and *Caliothrips indicus* (Bagnall), and negligible numbers of other species. The same is the case with *Panicum maximum*, where *Exothrips madrasensis* Ananthakrishnan and *Anaphothrips flavicinctus* occur in very large numbers, while *Chirothrips maximi* Ananthakrishnan and *Caliothrips indicus* occur in moderate numbers. The table below shows that *Anaphothrips flavicinctus*, *Neolimothrips saccharivora*, and *Caliothrips indicus* occur on several species of grasses and are hence polyphagous. All the same, *Anaphothrips flavicinctus* shows special preference for the guinea grass (*Panicum maximum*) and is abundant throughout the year. The same is true of *Neolimothrips saccharivora* which, though occurring on sugar cane leaves and *Chloris barbata* in good numbers, has a special preference for *Andropogon pertusus.* An interesting feature of this host preference is that, besides *Anaphothrips flavicinctus*, *Exothrips madrasensis* takes to *Panicum maximum* as the preferred host, and this species is very rarely met with in other species of grasses *Caliothrips indicus*, like *Anaphothrips flavicinctus*, is a highly polyphagous species, known to feed on several plants other than grasses. Instances of monophagous species are seen in *Haplothrips* (*Trybomiella*) *apicalis* Priesner which heavily infests *Cynodon dactylon* almost throughout the year, its distribution to the other host plants being restricted by its being primarily an apterous form, though macropterous and brachypterous forms are met with Ananthakrishnan (1957). Similarly, *Ramakrishnothrips jonnaphila* (Ramk.) inhabits the sheaths of *Sorghum vulgare*, while *Praepodothrips cymbopogonii* Ananthak. infests leaf blades of *Cymbopogon citratus*, and these species maintain this monophagous habit irrespective of the environment, whether it be in the plains or at heights of 5000-7000 feet as observed by the author in the Nilgiri and Kodaikanal hills.

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[1] *Zool. Anz.* **156** (1-2) : 29-33.

The following table gives the host-species index together with the degree of infestation :

Host	Thrips	Degree of incidence[1]			Distribution
		Frequent (over 25)	Meagre (below 10)	Accidental, or rare	
Andropogon pertusus	*Anaphothrips flavicinctus* Karny	X			Oriental
	Neolimothrips saccharivora Shumsher	X			India
	Caliothrips indicus (Bagnall)	X			India
	Sericothrips graminis Ananthakrishnan		X		India
	Phibalothrips peringueyi Faure	X			India & Africa
	Podothrips oryzae Priesner	X			India, Siam, & Java
	Hoplandrothrips indicus Ananthakrishnan			X	India
	Haplothrips apicalis Priesner			X	India
	Haplothrips gowdeyii (Franklin)			X	Cosmopolitan
Apluda aristata	*Anaphothrips sakimurai* Ananthakrishnan	X			India
	Aptinothrips rufus Gmelin		X		Cosmopolitan
	Caliothrips graminicola (Bagnall & Cameron)	X			India & S. Africa
	Caliothrips indicus (Bagnall)	X			India
	Chirothrips ramakrishnai Ananthakrishnan			X	India
	Chirothrips manicatus Haliday			X	Cosmopolitan

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[1] The numbers mentioned represent those collected in an area of 50 sq. yards,

Host	Thrips	Degree of incidence			Distribution
		Frequent (over 25)	Meagre (below 10)	Accidental, or rare	
Chloris barbata	*Neolimothrips saccharivora* Shumsher	X			India
	Chirothrips loyolae Ananthakrishnan	X			India
	Chirothrips manicatus Haliday			X	Cosmopolitan
	Chiraplothrips priesneri sp. nov.		X		India
	Phibalothrips peringueyi Faure		X		India & S. Africa
Cynodon dactylon	*Haplothrips* (*Trybomiella*) *apicalis* Priesner	X			India
Cymbopogon citratus	*Praepodothrips cymbopogonii* Ananthak.	X			India
Eragrostis sp.	*Caprithrips analis* Faure		X		India & S. Africa
	Aptinothrips rufus Gmelin		X		Cosmopolitan
Oryza sativa	*Thrips* (*Oxyrrhinothrips*) *oryzae* Williams	X			India
Panicum maximum	*Anaphothrips flavicinctus* Karny	X			India
	Chirothrips maximi Ananthakrishnan	X			India
	Exothrips madrasensis Ananthak.	X			India
	Caliothrips indicus (Bagnall)		X		India
Sorghum vulgare	*Ramakrishnothrips jonnaphila* (Ramk.)	X			India

Key to Genera of Grass-infesting Thrips

Suborder TEREBRANTIA

Family Thripidae Uzel

Upper surface of body deeply reticulate, with polygonal areas ; terminal antennal joints long and thin

Subfamily HELIOTHRIPINAE

Upper surface not polygonally reticulate, but at most with transverse striae. Antennae 7 or 8-jointed, rarely 6- or 9-jointed ; terminal joints not long and thin

Subfamily THRIPINAE

Subfamily HELIOTHRIPINAE

Antenna 8-jointed, style 2-jointed ; joints 3 and 4 with forked sense cones ; forewings with dark and pale transverse bands
Caliothrips Daniel
[*C. indicus* (Bagnall) and *graminicola* (Bagnall & Cameron)]

Antenna 7-jointed, style 1-jointed ; wings not banded
Phibalothrips Faure
(*P. peringueyi* Faure)

Subfamily THRIPINAE

1. Head distinctly produced in front of eyes into a projection on which is inserted the antenna 2

   Head little or not produced 3

2. Antennal joints 3 and 4 with forked sense cones ; mouth cone broadly rounded ; maxillary palpi 3-jointed
   Ramakrishnothrips Shumsher
   [*R. jonnaphila* (Ramk.)]

   Antennal joints 3 and 4 with simple sense cones ; mouth cone long and narrow ; maxillary palp 2-jointed
   Neolimothrips Shumsher
   (*N. saccharivora* Shumsher)

3. Pronotum without any strong bristles.. 4

   Pronotum with at least one conspicuous bristle at hind angles.. 6

   Pronotum with two well-developed bristles at hind angles .. 7

4. Wings and ocelli absent in both sexes.. 5

5. Antennae 6-jointed ; body long and slender ; dorsal bristles on IX fine ; teeth on abdominal sternites absent
   Aptinothrips Gmelin
   (*A. rufus* Gmelin)

   Antennae 8-jointed ; dorsal bristles on IX stout. Abdominal sternites with 10-15 teeth
   Caprithrips Faure
   (*C. analis* Faure)

6. Antennae 8-jointed, without a cross suture across joint 6; wings and ocelli always present in the females ; absent in the males. Foretibia of male unarmed
   Anaphothrips (Subgenus : *Neophysopus*)

Foretibia of male armed with a distinct tooth at apex within. Antennal joint 1 of male stout, joints 4 and 5 curved within ; females normal (*Anaphothrips*-like)

Exothrips Priesner
(*E. madrasensis* Ananthak.)

7. Antennae 8-jointed, style 2-jointed 8

Antennae 7-jointed, style 1-jointed 15

8. Pronotum with prominent anteroangular bristles .. 9

Pronotum without prominent anteroangular bristles .. 12

9. Maxillary palp 2-jointed 10

Maxillary palp 3-jointed 11

10. Antennae slender, style thin ; wings banded, narrow, with stout bristles ; anteroangulars shorter than anteromarginals

Ayyaria Karny
(*A. chaetophora* Karny)

11. Anteroangulars longer than anteromarginals ; both wing veins with regularly set bristles throughout their length ; antennal style normal

Frankliniella
(*F. sulphurea* Schmutz)

Pronotum with additional long bristle at lateral margin. Anteroangulars and posteroangulars and wing bristles very long

Scolothrips Hinds.
(*S. indicus* Priesner)

12. Forewings with both longitudinal veins distinct 13

Forewings with only the upper vein distinct, the lower vein being represented by a few scattered setae 14

13. Lower vein with only four scattered setae ; outer postangulars longer than inner .. ..

Euphysothrips Bagnall
(*E. minozii* Bagnall)

Lower vein with regular series of setae ; postangular prothoracic setae subequal .. .. ..

Taeniothrips A. & S.

14. Abdominal segment IX with numerous prominent bristles at posterior margin. Abdominal segments with dense microsetulae .. ..
Sericothrips Karny
(*S. graminis* Ananthak.)

15. Pronotum and wings without particularly long bristles. Wings without cross bars or dark areas 16

16. Mouth cone long and narrow surpassing base of prosternum
Thrips, Subgenus :
Oxyrrhinothrips Pr.
(*O. oryzae* Williams)

Mouth cone shorter, not surpassing prosternum
Thrips s. str.

Suborder TUBULIFERA

1. Wings not narrowed nor constricted at middle 2

Wings narrowed or constricted at middle 3

2. Cheeks with bristle-bearing warts ; forefemora of male, with one or two teeth at apex ; that of female unarmed
Hoplandrothrips Priesner
(*H. indicus* Ananthak.)

3. Forefemora and tibiae unarmed 4

Forefemora unarmed, foretibiae armed with teeth ; foretarsus with a well-developed tooth *Podothrips* Priesner
(*P. oryzae* Priesner)

4. Antennal joint 2 produced exteriorly, chirothripoid
Chiridothrips R. & M.
(*C. indicus* R. & M.)

Antennal joint 2 not chirothripoid ; cheeks parallel. Head about as long as wide ; mouth cone broadly rounded, never short. Foretibia normal *Haplothrips* Serville

Cheeks strongly convex ; mouth cone very short, broadly rounded. Foretibia pointed interiorly at apex
Praepodothrips
Priesner & Seshadri

Several other species have also been recorded in many random collections on grasses, but these are of little or no value to be reckoned among grass-infesting thrips. Some of these forms include *Erythrothrips asiaticus* R. & M., *Frankliniella sulphurea* Schmutz, *Ayyaria chaetophora* Karny, *Euphysothrips minozzii* Bagnall, *Scolothrips indicus* Priesner, and *Chiridothrips indicus* R. & M.

Caprithrips analis Faure

1933 : *Caprithrips analis* Faure, J. C., *Bull. Brook. Ent. Soc.* **28** (1 & 2): 12-14.

This genus is being recorded for the first time in the Oriental region. The only record of this interesting genus, which is monotypic, is by Faure (1933) from two apterous females, from the base of tufts of a grass from Pretoria (S. Africa). This genus is characterised by the 8-jointed antenna, joint 6 not divided ; cheeks narrower, straight ; eyes bulging ; sides of pronotum straight ; dorsal bristles of segment IX stout ; abdomen broadly conical at apex ; abdominal sternites with 10-15 teeth. Apterous.

Habitat : Ten females on *Eragrostis* sp., Madras, March 1959.

Caliothrips graminicola (Bagnall & Cameron)

1932, *Hercothrips graminicola* (Bagnall & Cameron), *Ann. Mag. Nat. Hist.* (10) : 412-419.

1957, *Caliothrips graminicola* Faure, J. C., *J. Ent. Soc. S. Africa* **20** (1) : 79-88.

This species is a new record to the Indian region, the only other species known hitherto being *C. indicus* (Bagnall). *C. graminicola* has pale forewings, with four, short, dark patches, one each at base, at apex and two in between. The forewings are narrow and the ring vein is strong and prominent. Blackish brown wing vein setae are absent. Costa of forewing has 5-8 setae at base and two at apex ; the lower vein has 4-7 setae, though a good many have only 4 or 5 setae.

Habitat: : Several males and females on the grass, *Apluda aristata*, Madras, March 1961.

Haplothrips (Chiraplothrips) priesneri sp. n.

Chiraplothrips[1] Priesner is reported for the first time from India and this subgenus is quite distinct from other allied subgenera of *Haplothrips* by the ' short and stout legs, forefemora at the apex of the outer margin, with a small tooth-like projection ; wings narrow, with double fringes ; joint 4 of antenna with only 2 sense cones'.

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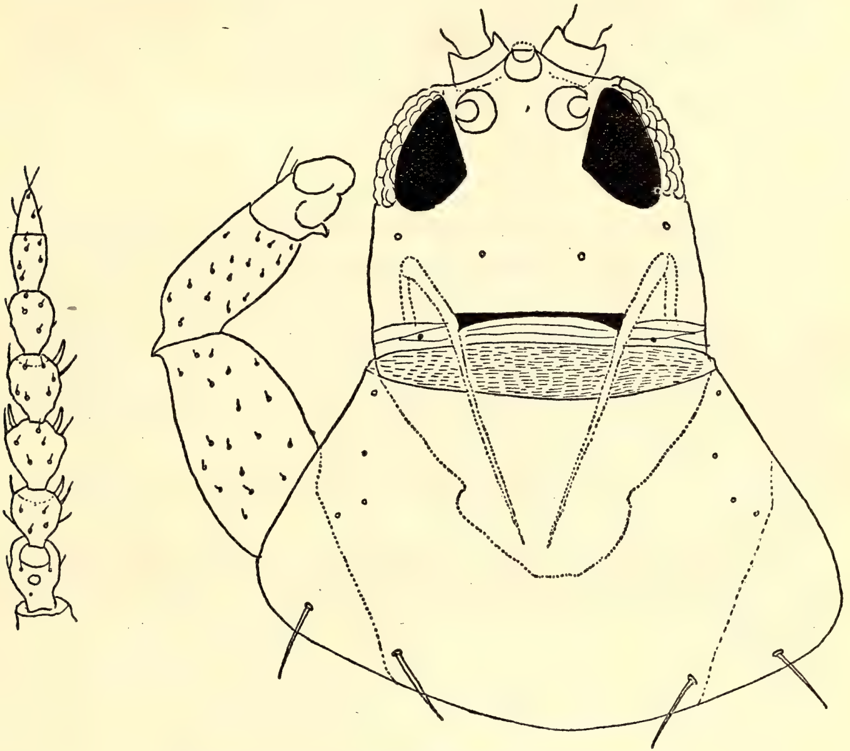
[1] Priesner, 1931, *Bull. de la Soc. Roy. Ent. d'Egypte* : 271-272

Macropterous female :

Body brown, inclusive of antennal joints ; abdomen and foretibia pale brown, the latter with yellowish tinge. Wings clear. Little red pigment scattered all over.



Haplothrips (*Chiraplothrips*) *priesneri* sp. n.

Head and antenna of female

Head 172 μ long, 154 μ wide across eyes and 168 μ across cheeks. Eyes 70 μ long and 49 μ wide. Ocelli placed above the middle region of eyes ; disposition broadly triangular ; median ocellus 16 μ wide, placed 29 μ from posterior ocelli, also 16 μ wide, placed 48 μ apart. Maxillary bridge 90 μ long, the maxillae at their point of articulation with the basal piece, 128 μ apart. Antennal joints short and stout, individual joints measuring, length (width) in μ :

29 (35) ; 48 (32) ; 38 (32) ; 45 (32) ; 43 (32) ; 43 (22) ; 38 (19) ; 32 (13).

Mouth cone 126 μ long, reaching about the middle of prosternum, 168 μ wide at base, 70 μ at tip, broadly rounded.

Prothorax 196 μ long at middle, 210 μ and 322 μ wide across anterior and posterior margins respectively. Forefemora moderately stout, *with a small tooth-like projection at apex, on outer margin* ; foretarsus with a small tooth.

Pterothorax, 350 μ long, 294 μ wide across mesothorax and 280 μ across metathorax. Forewings 1050 μ long, constricted at middle, with 7 accessory cilia. Basal wing spines short, disposed of in a broad traingle, 22, 22, and 19 μ long respectively.

Abdomen 294 μ wide at base and middle, gradually narrowing at apex. Abdominal segment VIII and IX, 266 and 140 μ wide respectively at base ; outer and inner bristle of IX 420 and 462 μ long. Tube 126 μ long, 70 μ wide at base and 35 μ at tip ; tube setae 112 μ long. Total body length 2.100 mm.

Macropterous male :

Coloration mostly as in the female, but with antennal joints 1 & 2 and 7 & 8 darker brown ; body with plenty of red pigment. Antennal joints, as a rule, stouter than in the female, individual joints measuring, length (width) in μ : 26 (28) ; 43 (32) ; 43 (32) ; 48 (32) ; 45 (26) ; 43 (26) ; 38 (22) ; 32 (16). Forefemora stouter than in female, 74 μ wide at middle ; foretarsus with a stouter tooth. Total body length : 1·64 mm.

Habitat : Holotype ♀ and allotype ♂, on *Chloris barbata*, Madras, January 1959.

This species is named in honour of Dr. Priesner of Linz (Austria) who examined the material.

This species differs from *C. faureanus* Priesner in the uniformly brown antennal coloration, and in the presence of 7 duplicate cilia on the forewing.

The Wildfowl Trust at Slimbridge in Britain

BY

E. P. GEE

(*With two plates*)

During July, August, and September 1960 I was fortunate enough to be able to spend a number of very pleasant and instructive days at the Wildfowl Trust at Slimbridge in the beautiful county of Gloucestershire in Britain. I have written this note in the belief that members of the Society and other readers of the *Journal* may like to know more about this extremely interesting place.

The Trust is situated on the flats of the southern shore of the broad Severn Estuary, 13 miles south-west of the city of Gloucester and very near the village of Slimbridge. Only a few miles to the east are the picturesque Cotswold Hills. On the Severn flats several thousand wild geese and ducks come every winter to feed, the main feeding grounds being just adjacent to the Trust itself, and members of the Trust have special facilities for viewing these wild birds at close quarters from hides near by. These wild geese are mostly White-fronted Geese from Russia, though all thirteen kinds of British geese have been recorded there.

Several hundred wild Mallard live and breed in the grounds of the Trust at Slimbridge, and during the winter many other wild duck such as Pintail, Shoveller, Teal, and Wigeon come into the pens of their own accord. There may be a thousand or more of these wild ducks in the Trust during the winter months, and they are very willing guests, and welcome ones too.

From the above, it may be assumed that the winter is the best time to see Slimbridge, especially as most of the drakes are in their best plumage (breeding plumage) at that time of the year. This is true—if you can pick a mild day with sunshine in the English winter! For obvious reasons, by far the greater number of visitors (including the writer himself) go to Slimbridge in the summer, the peak times of the largest numbers of visitors being the Whitsun weekend, and the holiday months of July, August, and September. The countryside is very nice during these summer months, but some of the wildfowl, especially the drakes, are moulting and are in their 'eclipse' plumage. For instance the Redcrested Pochard drake appeared to be neither red nor crested in July and August, and only towards the end of September began to look the handsome creature that it is.

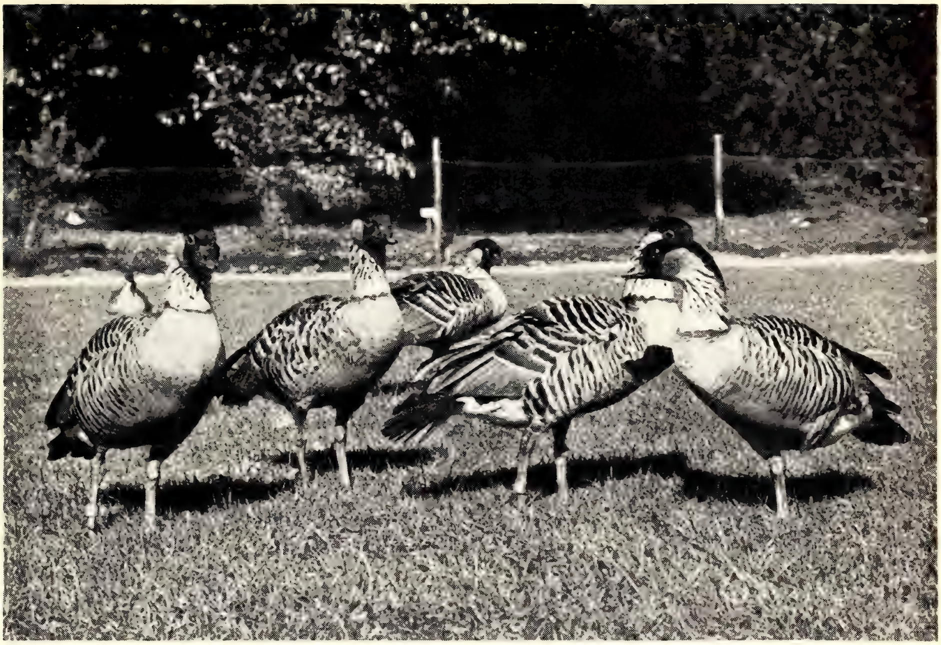
There is a branch of the Trust at Peakirk, near Peterborough in Northamptonshire, known as the Peakirk Waterfowl Gardens, opened to the public in 1957. Both at Slimbridge and at Peakirk are maintained and operated two of the last Duck Decoys in England: these are Berkeley New Decoy at Slimbridge, and Borough Fen near Peakirk. In these hundreds of wild ducks are caught, ringed, and released every year.

The Wildfowl Trust at Slimbridge was started in 1946, and is now the largest and most varied collection of swans, geese, and ducks in the world. There are some 1500 birds here, of 160 different species and races; and most of them are so tame that they will readily feed out of your hand. There is no notice displayed telling you to 'keep off the grass', but there is one politely asking you to 'be careful not to step on the birds'.

Most of the birds are pinioned, to prevent them flying away—mainly for their own safety, as they might get killed if they strayed from the grounds. But many are 'full-winged', and fly from pen to pen but seldom (if ever) leave. In particular, I noticed that a large number of Snow Geese (from Greenland and North America) were full-winged and yet were so tame that they were nearly always getting fed by visitors. There were also a few Barheaded Geese (central Asia and northern India, Pakistan, and Burma) that were flying about full-winged. Of these, a Barheaded had paired off with a Snow Goose, and this mixed pair together with a pair of Barheaded Geese were always together, in some part of the grounds or another.

Such 'mixed marriages' are not encouraged by the Trust, but are not always easy to prevent—as is evidenced by the large number of hybrids in the Hybrid Pen, where the results of strange crossings present a serious challenge to the experts when it comes to trying to identify them!

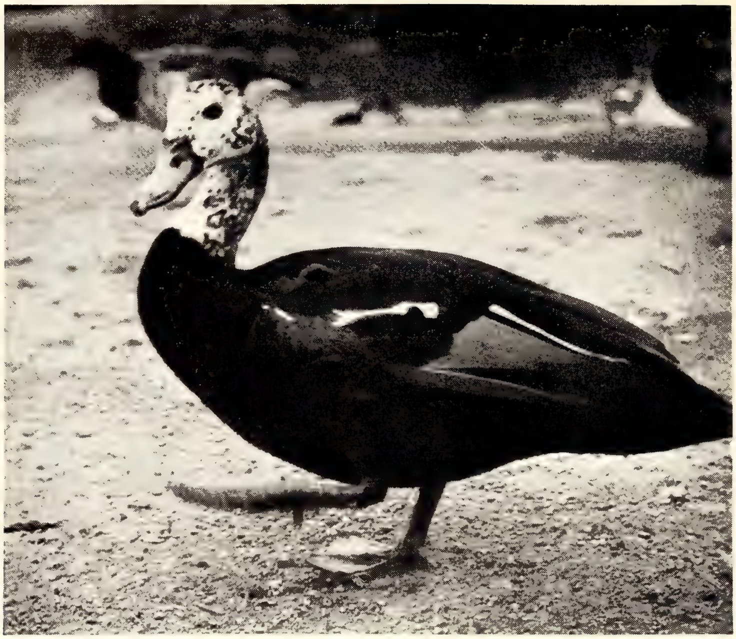
Probably the greatest triumph of wildfowl conservation at Slimbridge, and to a smaller extent at Peakirk, is the case of the Ne-ne or Hawaiian Goose, the rarest of all the world's geese. In 1947 there were only about 50 of these birds left in the whole world. The Trust brought three birds from Hawaii in 1950 and 1951, and these three had increased to no less than 126 in 1960, which was about half the total world population of this goose. It is hoped



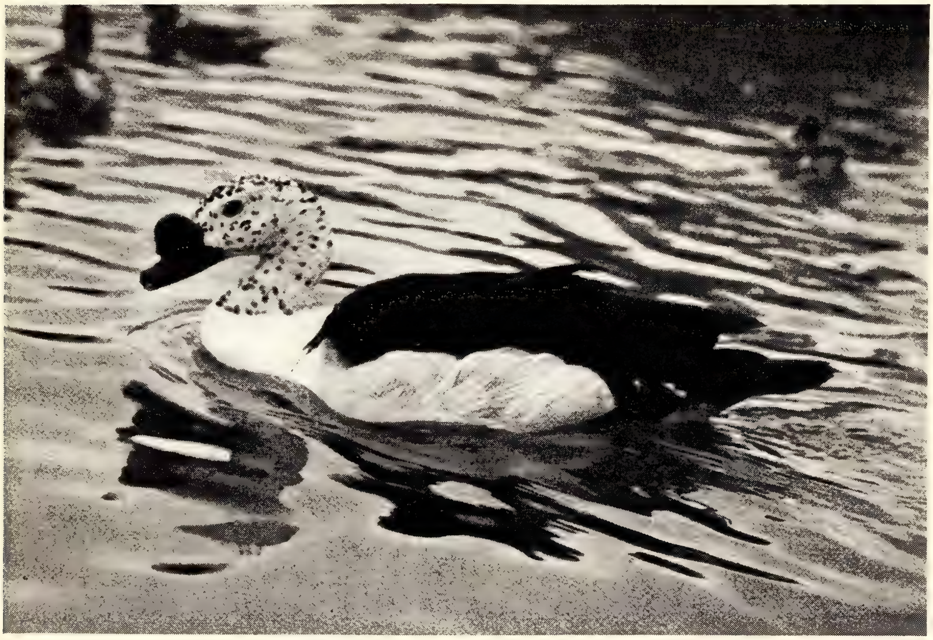
Hawaiian Geese or Ne-nes, one of the most important exhibits at the Wildfowl Trust

Part of the grounds of the Wildfowl Trust, as seen from the Acrow Tower

Photos : E. P. Gee



Whitewinged Wood Duck (drake) in Rushy Pen



Comb Duck or Nukta (drake) in Rushy Pen

Photos : E. P. Gee

to re-introduce some of these geese back into Hawaii some day. Hawaiian Geese are usually the first birds to greet you when you arrive at Slimbridge, and they are so tame that they almost besiege you for food, taking tit-bits from your hand very gently and carefully —never biting your fingers in the process.

When I was there, I saw the Trumpeter Swans which had been presented to the Queen, who is Patron of the Trust, by the Canadian Government on her tour of that dominion, and which have been placed in the care of the Trust. These are the largest of all wildfowl, and the heaviest of all flying birds, weighing up to 30 lb. There are probably not more than 1300 of them alive in the world today. There was a nest of these swans in 1960, providing one of the very few breeding records of this rare and magnificent swan, but unfortunately the five eggs never hatched. Another nest is reported in 1961 and results are awaited.

In Rushy Pen are nearly all the fish-eating ducks. Here I was most interested to see a pair of the rare Whitewinged Wood Duck, a species which is found in north-east India, East Pakistan, Burma, and south-east Asia. Apparently nine of these ducks were given to the Trust by a Buddhist monk of southern Thailand about 1954, and three of them died before 1960. In 1960 another four of them died of lung fungus. The remaining pair nested in the spring of 1960, but nothing came of it.

Apart from the last mentioned species, the breeding results at the Wildfowl Trust are very good indeed. Nearly 100 species and subspecies breed every year here, and in 1960 no less than 1100 young birds were successfully reared. Six species and several subspecies have bred in captivity for the first time ever in the grounds of the Trust. I saw a pair of Bewick's Swans nesting—the only breeding pair in captivity in the world. These swans in the wild state breed in northern Russia and northern Siberia, and winter in northern Europe and central Asia.

The Wildfowl Trust is a non-profit organization, devoted to the study of wildfowl both captive and wild. There is a research wing, for the study of wildfowl biology including feeding, behaviour, food consumption, diseases, mortality, migration, homing, orientation, and so on.

While the Trust owes its inception to the man who is now its Honorary Director, Peter Scott, it surely owes its existence and continuance to the enthusiastic support of the nature-loving British people, who go there in large numbers not only to observe the wildfowl but also to enjoy a quiet and peaceful day's recreation in the countryside. The total number of visitors to Slimbridge and Peakirk in the twelve months ending August 1959 was 157,000. Many foreign tourists go there, and the Trust has undoubtedly become a major tourist attraction of Britain.

One of the things that struck me most, going there after many years in India, was the fact that many schoolboys go there in their holidays to work—for no pay at all. So great is their enthusiasm for bird watching, that boys from even the most exclusive of schools go there, stay in a local hotel at their own expense, and work—hard manual work making new ponds, digging, and shovelling, and so on —simply for the privilege of being inside the Trust and being among all the wildfowl, for no pay (Indian school boys, please note!). I met several of these boys, and they knew the names of practically all the birds, and where they came from. Their enthusiasm was remarkable.

The place is a bird photographer's paradise. The great difficulty is to keep far enough away from the birds, as they will come up to you, so tame are they.

There is an opportunity for us in India to develop something along these lines. A Slimbridge in India would not only help us in some of our conservation problems by preserving and breeding the rarer species, but also it would be a tourist attraction in a new country which is fast building up her tourist industry. If no special place for wildfowl alone can be developed, then surely one of our better zoological gardens could specialise in the keeping and exhibiting of wildfowl in natural conditions, with plenty of privacy for nesting birds. Such a project would be a wise and far-sighted undertaking, especially in view of the present rapid and alarming extermination of wild life all over the country.

Vegetation of Jhunjhunu, Mandrela, and the Neighbouring Places

BY

N. C. NAIR

Department of Botany, Birla College, Pilani, Rajasthan[1]

(*With a map and a plate*)

Studies on the vegetation of the arid and semi-arid regions of Rajasthan have, in recent years, increased in both importance and number. Still Rajasthan forms a floristically little-known part of India. There is no complete published account of the flora of the region similar to the floras of Madras, Bombay, Behar, Orissa, Bengal, Punjab, etc., and the need for a flora of this arid tract is very pressing. Therefore, any contribution to the study of the vegetation of this area is of interest and importance.

Joshi (1957, 1958) and Joshi & Khamboj (1959) have reviewed the earlier literature. Other recent contributions include those of Nair & Kanodia (1959) on the vegetation of Ajit Sagar.

A perusal of the literature reveals that most of the floristic investigations of the area relate to cities or important towns that are accessible by railway or motorable road, whereas there are many places in the interior of the arid and semi-arid zones of Rajasthan which hardly any botanist has visited.

The present account is based on a preliminary study of the vegetation of Jhunjhunu, Mandrela, Manpura, Dilarpur, Bhaktavarpura, Dhattarwala, Kasimpura, Bagar, Gumansir, Bhamarwasi, and Lalpur (see map). In this study particular attention was paid to the Katli River bed. In the attached list only trees and shrubs that constitute the structural framework of the vegetation are included. The herbaceous flora will be published after making intensive periodic collections.

VEGETATION

A general account of the climate, soil, and plant associations of Jaipur division was given by Joshi (1957), in which mention is also made of Jhunjhunu and its neighbouring places. A detailed ecological account of the vegetation will, therefore, be superfluous. However, a few words must be said about the vegetation of the interior places and the bed of the Katli River.

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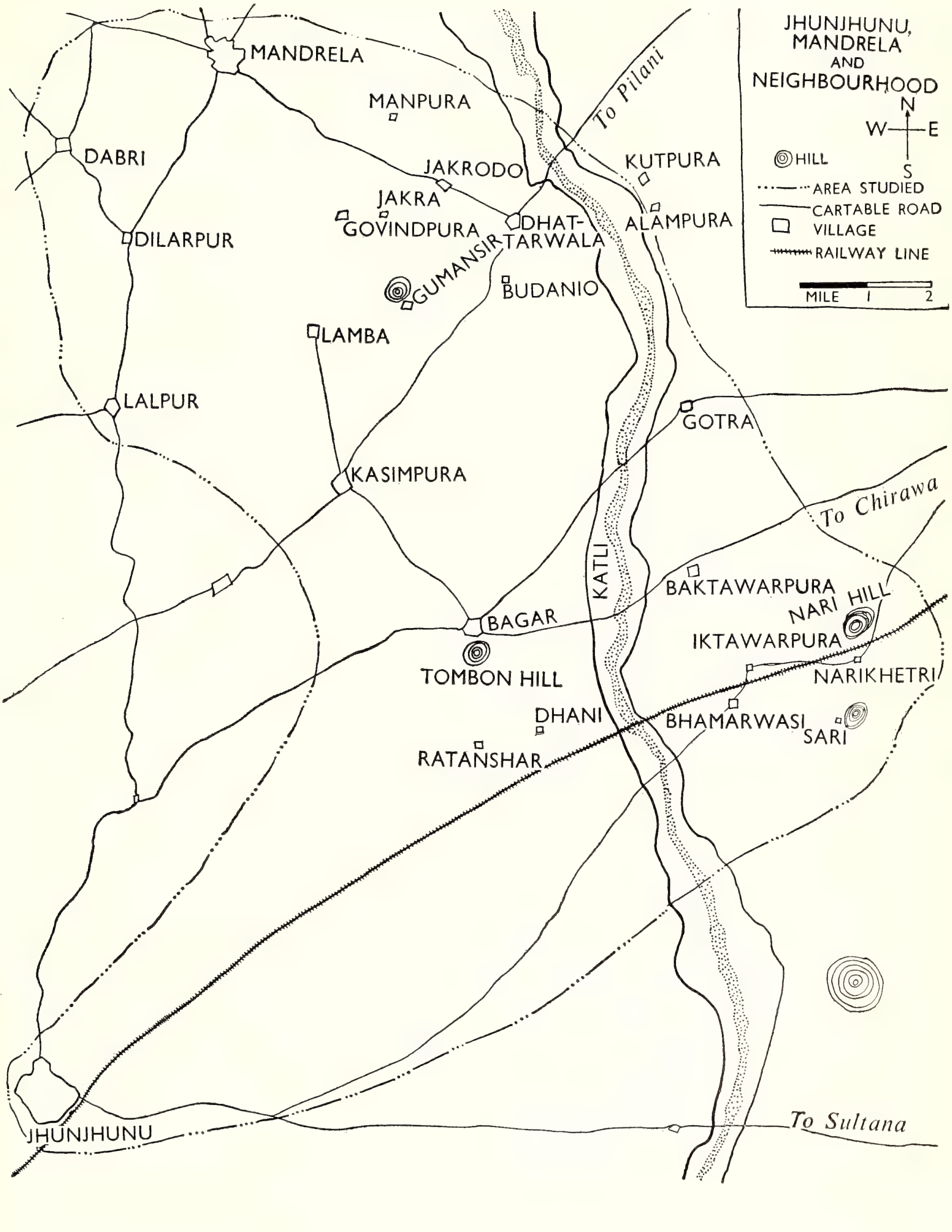
[1] Present address: Botanical Survey of India, Dehra Dun.

The vegetation in the area reveals a striking uniformity being typically a thorny scrub. The components of the vegetation are characteristically similar to those found in adjacent areas (cf. Bakshi, 1954 ; Nair & Nathawat, 1956 ; Nair & Joshi, 1957 ; Joshi, 1958). The open dry vegetation is characterised by associations of *Prosopis*, *Capparis*, *Gymnosporia*, *Calotropis*, *Leptadenia*, etc. In some places near Mandrela there are extensive associations of *Salvadora*, *Zizyphus*, and *Balanites*. In the vast plains near Bhamarwasi and Jhunjhunu the vegetation is very sparse. The soil although stabilized supports only a few tree species like *Prosopis spicigera*, *Acacia arabica*, *Acacia leucophloea*, etc. scattered singly here and there (Fig. 2). Very often these trees are mutilated by cutting down the branches for fodder.

The road from Chirawa to Mandrela is lined on either side with a more or less uniform vegetation consisting of trees like *Capparis*, *Prosopis*, *Balanites*, *Tecomella*, *Acacia*, *Zizyphus*, etc. One significant feature is that at places *Tecomella* forms the dominant element. The undergrowth includes *Tephrosia*, *Justicia*, *Peristrophe*, *Sida*, etc. There are a few sandy localities where the sand forms rippled dunes. These dunes are practically devoid of any vegetation (Fig. 1), except stray plants of *Boerhavia verticillata*, *Aerva javanica*, etc. In the close vicinity of these rippled dune areas are found stabilized dunes of varying size, the largest of them being sometimes over thirty feet in height. These dunes support very good vegetation of *Capparis*, *Gymnosporia*, *Ephedra*, *Balanites*, *Erianthus*, etc. Very often trees of considerable size like *Prosopis spicigera*, *Tecomella undulata*, and *Acacia arabica*, are seen growing on the summit of these dunes. It must be mentioned that these tree species have a very slow rate of growth. Seemingly, therefore, the dunes got stabilized a considerable time ago by encroaching vegetation. This excites two questions. Were the conditions in these places more intense than at present ? Is the area under consideration in a state of natural regeneration ? Obviously, a thorough study of the nature, rate, and trends of dune stabilization is necessary before anything can be said with certainty.

The banks of the Katli River (though called a river it contains water only during July-September) are almost sandy and desolate. Here and there pure associations of *Leptadenia pyrotechnica*, *Calligonum polygonoides*, and *Erianthus munja* are present. At one or two places the encroaching vegetation has made the sand stable.

There are only very few hills in the area studied. These are rocky and barren. Sometimes stray plants of *Acacia senegal* and *Azadirachta indica* are seen. One significant feature is the conspicuous absence of *Euphorbia nivulia* and *E. neriifolia*, that are characteristic of the hills of Rajasthan (*see* Nair & Nathawat, 1956 ; Nair & Kanodia, 1959), from these hills. Only at one place, near Mandrela, a few clumps of *Euphorbia*


JHUNJHUNU, MANDRELA AND NEIGHBOURHOOD
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AREA STUDIED
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VILLAGE
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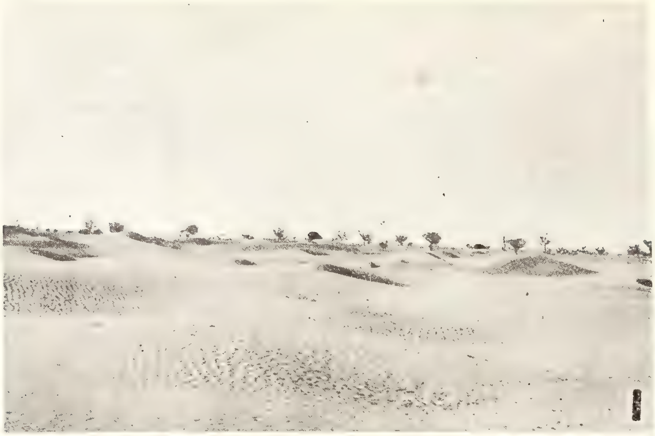
MANDRELA
MANPURA
DABRI
JAKRODO
JAKRA
GOVINDPURA
DHAT-TARWALA
DILARPUR
GUMANSIR
BUDANIO
LAMBA
To Pilani
KUTPURA
ALAMPURA
LALPUR
GOTRA
KASIMPURA
To Chirawa
KATLI
BAKTAWARPURA
NARI HILL
IKTAWARPURA
BAGAR
TOMBON HILL
NARIKHETRI
DHANI
BHAMARWASI
SARI
RATANSHAR
JHUNJHUNU
To Sultana



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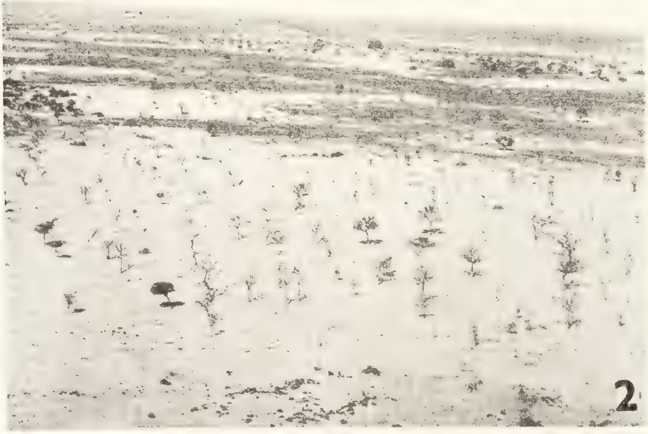

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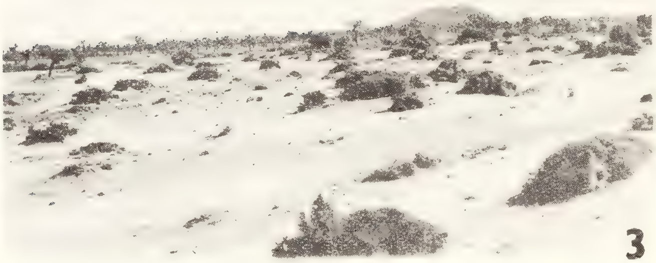

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Fig. 1. A rippled dune area near Mandrela. Fig. 2. A bird's eye view of the plains near Jhunjhunu showing trees of *Prosopis spicigera*, *Acacia arabica* and *A. leucophloea* spotted here and there. Fig 3. The vegetation near about a hilly area. Note the stunted and cushion-shaped form of the plants like *Securinega leucopyrus*, *Zizyphus*, *Gymnosporia*, etc.

nivulia were seen cultivated as a hedge. Near about the hills, in the plains, the vegetation is peculiar in that plants such as *Gymnosporia spinosa*, *Zizyphus nummularia*, *Securinega leucopyrus*, etc. exhibit a stunted cushion-shaped appearance (Fig. 3). Whether this peculiar form is due to edaphic or biotic (grazing) or both factors remains unanswered for the present.

Large temporary ponds are present here and there. The trees growing near about these ponds reach a height of 45-50 feet (13-15 m.). The most common trees around such ponds are *Capparis decidua*, *Balanites aegyptiaca*, *Anogeissus pendula*, and *Salvadora persica*.

Jhunjhunu is the district headquarters. As a result of afforestation work in the area many trees have been planted in and near about Jhunjhunu, and this imparts a green appearance to the neighbourhood. In the outskirts of villages and towns pure associations of *Xanthium strumarium* and *Croton bonplandianum* are frequently seen.

LIST OF PLANTS

1. ANNONACEAE

*__Annona squamosa__ Linn.
*__Polyalthia longifolia__ B. & H.

2. MENISPERMACEAE

Cocculus pendulus (Forst.) Diels
Tinospora cordifolia Miers

3. CAPPARIDACEAE

Capparis decidua (Forsk.) Pax.
Merua arenaria Hk. f.

4. TAMARICACEAE

Tamarix aphylla (Linn.) Karst.

5. MALVACEAE

Pavonia zeylanica Cav.
Sida grewioides Guill. & Perr.
Sida cordifolia Linn.
Abutilon fructicosum Guill. & Perr.
*__Abelmoschus esculentus__ Linn.
Salmalia malabarica (DC.) Schott. & Endl.
*__Hibiscus rosa-sinensis__ Linn.

6. TILIACEAE

Grewia tenax (Forsk.) Fiori.
*__G. asiatica__ Linn.
G. oppositifolia Roxb.
Corchorus tridens Linn.
C. aestuans Linn.

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*Cultivated

7. ZYGOPHYLLACEAE

Fagonia cretica Linn.

8. GERANIACEAE

***Averrhoa carambola** Linn.

9. RUTACEAE

***Citrus aurantium** Linn.
***Citrus medica** var. **acida** Roxb.
***Feronia limonia** (Linn.) Swingle
***Aegle marmelos** Correa
***Murraya paniculata** (Linn.) Jack.
***M. koenigii** (Linn.) Spreng.

10. SIMAROUBACEAE

Balanites aegyptiaca Linn.
Ailanthus excelsa Roxb.

11. MELIACEAE

***Melia azedarach** Linn.
Azadirachta indica Juss.

12. CELASTRACEAE

Gymnosporia spinosa (Forsk.) Fiori.

13. RHAMNACEAE

Zizyphus nummularia (Burm. f.) W. & A.
Z. xylopyra Willd.
***Z. mauritiana** Lamk.

14. SAPINDACEAE

Dodonaea viscosa L.

15. ANACARDIACEAE

***Mangifera indica** Linn.

16. MORINGACEAE

Moringa oleifera Lamk.

17. LEGUMINOSAE

Crotolaria medicaginea Lamk.
C. burhia Hamilt.
Cyamopsis tetragonoloba (Linn.) Taub.
Indigofera tinctoria Linn.
Rhynchosia minima DC.
Tephrosia purpurea Pers.
Abrus precatorius Linn.
Sesbania sesban var. **picta** Santapau
***C. fistula** Linn.
C. auriculata Linn.
***Parkinsonia aculeata** Linn.
***Tamarindus indica** Linn.
***Bauhinia** sp.
***Delonix regia** (Boj.) Raf.
Caesalpinia pulcherrima Swartz.
Prosopis spicigera Linn.

Clitoria ternatea L.
***Phaseolus** sp.
Dalbergia sissoo Roxb.
***Butea monosperma** (Lamk.) Taub.
***Erythrina variegata** var. **orientalis** (Linn.) Merr.
Cassia occidentalis Linn.
C. obtusa Roxb.
***C. siamea** Lamk.
***P. juliflora** DC.
Mimosa hamata Willd.
Acacia arabica Willd.
A. senegal Willd.
A. leucophloea Willd.
A. catechu Willd.
***A. farnesiana** Willd.
Albizzia lebbeck Benth.

18. ROSACEAE

***Rosa indica** Linn.

19. COMBRETACEAE

Anogeissus pendula Edgw.
***Terminalia arjuna** Bedd.
***Quisqualis indica** L.

20. MYRTACEAE

***Syzygium cumini** (Linn.) Skeels.
***Eucalyptus** sp.
***Psidium guajava** Linn.

21. LYTHRACEAE

***Lagerstroemia indica** Linn.
***Lawsonia inermis** Linn.
***Punica granatum** Linn.

22. CARICACEAE

***Carica papaya** Linn.

23. CUCURBITACEAE

Coccinia cordifolia (Linn.) Cogn.
Citrullus colocynthis Schrad.

24. CACTACEAE

Opuntia dillenii Haw.

25. COMPOSITAE

Xanthium strumarium Linn.

26. OLEACEAE

***Jasminum** sp.
***Nyctanthes arbor-tristis** Linn.

27. SALVADORACEAE

Salvadora persica Linn.
S. oleoides Decne.

28. APOCYNACEAE

***Nerium indicum** Mill.
***Lochnera rosea** (Linn.) Reichb.
***Thevetia peruviana** (Pers.) K. Schum.
***Plumeria rubra** Linn. forma **acutifolia** (Poir.) Woodson
***Carissa carandas** Linn.
* **Ervatamia coronaria** Stapf.

29. ASCLEPIADACEAE

Calotropis procera R. Br.
C. gigantea R. Br.
Pergularia daemia (Forsk.) Chiov.
Leptadenia pyrotechnica (Forsk.) Decne.
Ceropegia tuberosa Roxb.
Cryptostegia grandiflora R. Br.

30. BORAGINACEAE

Cordia dichotoma Forsk. f.
C. rothii Roem.

31. CONVOLVULACEAE

***Ipomoea cairica** (Linn.) Sweet.
***Ipomoea pescaprae** (Linn.) Sweet.
***Argyreia nervosa** (Burm. f.) Boj.

32. SOLANACEAE

Solanum xanthocarpum S. & W.
S. indicum Linn.
Physalis peruviana Linn.
Datura metel Linn.
Lycium europaeum Linn.
Withania somnifera Dunal
***Capsicum frutescens** L.
***Solanum melongena** Linn.
***Cestrum nocturnum** Linn.

33. BIGNONIACEAE

Tecomella undulata (Smith) Seem.
***T. stans** (Linn.) H.B.K.
***Jacaranda mimosaefolia** D.Don.
***Kigelia pinnata** DC.
***Millingtonia hortensis** Linn.

34. PEDALIACEAE

Martynia annua Linn.
Sesamum indicum DC.

35. ACANTHACEAE

Dipteracanthus patulus (Jacq.) Nees
D. prostratus (Poir.) Nees
Barleria prionitis Linn.
Lepidagathis trinervis Nees
Peristrophe bicalyculata Nees
Adhatoda vasica Nees

36. VERBENACEAE

Stachytarpheta indica Vahl.
***Vitex negundo** Linn.
Clerodendrum phlomidis Linn.
C. inerme Benth.
***Duranta repens** Linn.
Lantana camara Linn. var. **aculeata** (Linn.) Moldenke

37. NYCTAGINACEAE

Boerhavia verticillata Poir.
***Bougainvillea** sp.
***Mirabilis jalapa** Linn.

38. AMARANTHACEAE

Aerva javanica (Burm. f.) Spreng.
A. pseudotomentosa Blatter & Hallberg
Amaranthus spinosus Linn.

39. POLYGONACEAE

Calligonum polygonoides Linn.
***Antigonon leptopus** Hook. & Arn.

40. EUPHORBIACEAE

Euphorbia nivulia Buch.-Ham.
***Emblica officinalis** Gaertn.
Securinega leucopyrus (Willd.) Muell. Arg.
Ricinus communis Linn.
Croton bonplandianum Baill.

41. MORACEAE

***Morus alba** Linn.
Ficus glomerata Roxb.
F. benghalensis Linn.
***F. religiosa** Linn.
***F. carica** Linn.

42. SCITAMINACEAE

***Musa sapientum** Linn.
***Canna indica** Linn.

43. AMARYLLIDACEAE

***Agave** sp.
***Crinum asiaticum** Linn.

44. LILIACEAE

Aloe barbadensis Mill.

45. PALMAE

***Phoenix sylvestris** Roxb.

46. GRAMINEAE

Erianthus munja (Roxb.) Jesweit
***Saccharum officinale** Linn.
***Arundo donax**
***Zea mays** Linn.
***Pennisetum typhoides** (Burm. f.) Stapf. & Hubb.

47. GNETACEAE

Ephedra foliata Boiss.

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The Birds of Nepal

PART 4

BY

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[*Continued from Vol.* **58** (1) : 134]

Order PASSERIFORMES

Family EURYLAIMIDAE

*330. **Serilophus lunatus rubropygius** (Hodgson). Hodgson's Broadbill.

The only record of Hodgson's Broadbill from Nepal is based on Hodgson's collection (Gray & Gray, 1846, p. 56).

331. **Psarisomus dalhousiae dalhousiae** (Jameson). Longtailed Broadbill.

DUN : Hitaura, Kusumtar, Bhimphedi : 7 ♂♂, 6 ♀♀ (May 5-25, June 2, 3, 19).

The Longtailed Broadbill is common about ravines in dense forests of the central duns. Both Scully (1879) and Ripley (1950b) failed to notice it in Nepal, but Rand & Fleming (1957, p. 98) recorded it from west-central Nepal at about 760 m.

A male had somewhat enlarged testes on June 3 : R : 4·5 × 2·5 mm.; L : 6 × 3·5 mm.

Colours of soft parts : Iris brown; bill green with yellow on anterior two-third of culmen and yellowish green on edges ; legs and feet dull green ; claws dark horny ; pads white.

Measurements :

	7 ♂♂	6 ♀♀
Wing :	107, 111, 113 (2), 114 (2), 116	96, 99, 102 (2), 103 (2)
Tail :	116, 120, 122 (2), 124, 131, 132	116, 118, 119, 121, 122, 127
Bill :	21 (2), 22 (4), 22.5	21 (2),—, 22 (3)

The apparent sexual dimorphism in size can be proved only by measuring many more correctly sexed specimens.

Family PITTIDAE

*332. **Pitta nipalensis nipalensis** (Hodgson). Bluenaped Pitta.

Proud (1952b, p. 669) was the first to report it from Nepal after Hodgson. She found it only once in the Nepal Valley in January. Subsequently, Rand & Fleming (1957, p. 98) obtained a few specimens from the Nepal Valley in February.

*333. **Pitta brachyura brachyura** (Linnaeus). Indian Pitta.

Hodgson's collection (Gray & Gray, 1846, p. 78) provides the sole record of the Indian Pitta in Nepal.

334. **Pitta sordida cucullata** Hartlaub. Greenbreasted Pitta.

Dun : Hitaura, Kusumtar : 9 ♂♂, 3 ♀♀ (May 11-29, June 3).

The Greenbreasted Pitta is not an uncommon bird of the central dun in dense forest, particularly at spots rich in undergrowth or where the ground is covered with fallen leaves. Scully (1879), Ripley (1950b), and Rand & Fleming (1957) all failed to find this pitta in Nepal. It would, therefore, appear that ours is the first post-Hodgsonian record of the species from Nepal.

A male specimen had much swollen testes[1] on June 3.

Colours of soft parts : Iris dark brown ; bill black ; legs and feet dark slate ; claws yellowish grey.

Measurements :

	9 ♂♂	3 ♀♀
Wing :	108, 110, 111, 113, 114 (2), 115 (2) 118	110, 112, 113
Tail :	37, 37·5, 38 (4), 39,—, 41	37, 37·5, 40
Bill :	24·5, 25 (2), 26 (2), 27 (4)	25 (2), 25·5

Family ALAUDIDAE

*335. **Mirafra assamica assamica** Horsfield. Bengal Bush Lark.

Since Hodgson's collection from the tarai (Gray & Gray, 1846, p. 109), the Bengal Bush Lark has been reported from Nepal only by Rand & Fleming (1957, p. 99) from the western lowlands in winter and the central plains in spring.

*336. **Eremopterix grisea** (Scopoli). Ashycrowned Finch-Lark.

The post-Hodgsonian records of the Ashycrowned Finch-Lark from Nepal consist of Scully's (1879, p. 337) who found it to be common in the plains and tarai of central Nepal in winter, and Rand & Fleming's (1957, p. 99) who noted small flocks in the western and eastern tarai in winter.

*337. **Calandrella cinerea dukhunensis** (Sykes). Rufous Short-toed Lark.

The last Nepali record of this short-toed lark is based on Scully's (1879, pp. 337-338) finding it on passage in the Nepal Valley on autumnal migration (October).

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[1] The right testis was present in two lobes, an abnormal condition. The case had already been reported (Biswas, 1961c).

*338. **Calandrella acutirostris tibetana** Brooks. Brooks's Short-toed Lark.

The only post-Hodgsonian record of Brooks's Short-toed Lark from Nepal has been provided by Biswas (1960a) who reported it from *c.* 4570-5030 m. in Khumbu, eastern Nepal, in May.

*339. **Calandrella raytal raytal** (Blyth). Ganges Sandlark.

Scully (1879, p. 338) noted this lark to be common in the plains of central Nepal, close to the tarai, in December, and Rand & Fleming (1957, p. 99) obtained a single example from the eastern tarai also in December. These constitute the only post-Hodgsonian records of the species from Nepal.

*340. **Galerida cristata chendoola** (Franklin). Franklin's Crested Lark.

The post-Hodgsonian records of Franklin's Crested Lark from Nepal are Scully's (1879, p. 338) who found it common in the central plains near the tarai in winter, and Rand & Fleming's (1957, p. 99) from the central plains near the Indian border (Birganj) in April.

*341. **Alauda gulgula lhamarum** R. & A. Meinertzhagen. Kashmir Skylark.

Scully (1879, p. 338) was the first to report the occurrence of the Kashmir Skylark in Nepal from a single specimen taken in the Nepal Valley in February. He observed it in Nawakot district also, but since he took no specimen there, he entered it in his Nawakot list (op. cit., p. 367) with a question mark (see Ripley 1950b, p. 380 in this connexion). Later Ripley (loc. cit.) found it in the Nepal Valley and in western Nepal in December. Rand & Fleming's (1957, p. 98) specimens from western, central, and eastern Nepal were not identified subspecifically. I am unable to state, therefore, if they represent this form or the eastern *inopinata* or both.

Vaurie (1959a, p. 59) gives the range of this form eastward up to the Punjab, placing the Nepal birds under *inopinata*. Ripley (in press), however, gives Nepal as the eastern limit of this subspecies.

342. **Alauda gulgula inopinata** Bianchi. Tibetan Skylark.

NEPAL VALLEY : Thankot : 2 ♂♂, 2 ♀♀ (April 8-12).

The Tibetan Skylark is found in small flocks in central Nepal. It occurs in the paddy fields during March-April.

Scully (1879, p. 338) had earlier recorded it from the Nepal Valley in February-March.

Measurements :

	Wing	Tail	Bill
2 ♂♂ :	102, 105	64, 68	15·5, 16·5
2 ♀♀ :	97, 99	59, 60	15·5, 16·5

All these four specimens have already been studied and reported upon by Vaurie (1951c, pp. 518, 522).

*343. **Eremophila alpestris elwesi** (Blanford). Elwes's Horned Lark.

I am unable to trace any record of Elwes's Horned Lark from Nepal after Hodgson's collection (Gray, 1863, p. 58).

Family HIRUNDINIDAE

344. **Riparia paludicola chinensis** (J. E. Gray). Indian Sand Martin.

NEPAL VALLEY : nr. Kathmandu : 2 juv. ♂♂, 2 juv. ♀♀ (April 5).

During late March and early April the Indian Sand Martin is found to be common in flocks of 30-50 in the outskirts of Kathmandu, not far from streams. On April 5, 1947, a large congregation of this sand martin was noticed busily feeding on the myriads of insects that were disturbed by the harvesting of pulses in a field situated on the bank of a stream.

Scully (1879, p. 234) found it a resident bird of the Nepal Valley, and reported it also from the Markhu Valley and Nawakot district in winter. Ripley (1950b, p. 381) recorded it from the western tarai and the Nepal Valley in winter. Rand & Fleming (1957, p. 100) found it in the western, west-central and eastern tarai and foothills in winter.

The coloration of the upper parts of my specimens agrees nicely with that given by Baker (1926, p. 235) for the young birds, but the chin, throat and breast have a rufous wash.

*345. **Riparia riparia diluta** (Sharpe & Wyatt). Collared Sand Martin.

The only post-Hodgsonian record of this sand martin from Nepal is based on Proud's (1949, p. 711) sight record in the Nepal Valley throughout the year along river banks. It is significant to note here that the very common Indian Sand Martin was missed by her in the Nepal Valley.

*346. **Hirundo rupestris** Scopoli. Crag Martin.

We were unable to find the Crag Martin in Nepal. Scully (1879, p. 234), however, noted it in central Nepal (Nepal and Markhu Valleys and Nawakot district) in winter. Ripley (1950b, p. 380) found it at *c.* 1525 m. in eastern Nepal in February. Rand & Fleming (1957, p. 100) reported it from west-central Nepal (*c.* 915 m.) in December.

347. **Hirundo rustica rustica** Linnaeus. Common Swallow.

DUN : Bhimphedi 1 ♂, 1 ♀ (March 12, 14). NEPAL VALLEY : Thankot : 1 ♂, 2 juv. ♂♂, 1 ♀ (March 21, 31, April 13, 14).

The Common Swallow was observed by us from the upper dun

(Bhimphedi area) to the Nepal Valley from about the middle of March. It was breeding in Bhimphedi area in mid-March.

Measurements :

	Wing	Tail	Bill
2 ♂♂ :	121, 123	90, 94	12 (2)
2 ♀♀ :	116, 117	77, 79	12 (2)

The abovementioned specimens have been studied and reported upon by Vaurie (1951b, pp. 19-25).

348. **Hirundo rustica gutturalis** Scopoli. Eastern Swallow.

Dun : Hitaura : 2 juv. ♀♀ (July 15).

This appears to be the only record of the Eastern Swallow from Nepal. For notes on these specimens, see Vaurie (1951b, pp. 23, 25).

*349. **Hirundo smithii filifera** Stephens. Indian Wiretailed Swallow.

Although not listed in either edition of the catalogue of Hodgson's collection (Gray & Gray, 1846 ; Gray, 1863), two specimens of the Indian Wiretailed Swallow presented by Hodgson to the British Museum have been included by Sharpe (1885, p. 151). The locality for one of them has been given as Nepal, and for the other ' Behar '. There does not seem to be any other record of the species from Nepal.

*350. **Hirundo daurica daurica** Linnaeus. Daurian Striated Swallow.

The only record of the Daurian Striated Swallow from Nepal appears to be that of Ripley (1950b, p. 380) who took a single example in central Nepal at *c.* 1525 m. in December.

351. **Hirundo daurica nipalensis** Hodgson. Hodgson's Striated Swallow.

DUN : Hitaura, Bhimphedi : 1 ♂, 1 juv. ♂ (May 6, June 2). CHITLANG VALLEY : Chitlang : 2 ♂♂, 2 ♀♀ (March 15-18). NEPAL VALLEY : Kathmandu, Thankot, Godavari : 4 ♂♂, 5 ♀♀ (March 22-April 10, May 16).

Hodgson's Striated Swallow is very common in the Nepal Valley as well as in the lower ranges, usually in and around towns and villages. Rand & Fleming (1957, p. 100) reported it from western, west-central and central Nepal, at *c.* 275-1980 m. in winter. Biswas (1960a) recorded it from eastern Nepal at *c.* 1525-2240 m. in June.

In April and May it was breeding in Chitlang and Nepal valleys. Specimens taken in March had slightly swollen gonads ; those in April had them more enlarged (a male, April 6, had the right testis 5 × 5 mm., and a female of same date had 8 × 5 mm. ovary with a 2.5 mm. ovum), while a female taken May 16, had the ovary more developed.

Colours of soft parts: Iris dark brown ; bill black ; legs and feet dark horny ; claws black ; pads greyish white.

Measurements :

	7 ♂♂	7 ♀♀
Wing :	115, 116 (3), 117, 118, 120	109, 115 (3), 116 (2), 120
Tail :	86, 91 (2), 92, 96, 97, 102	82, 86 (2),—, 90, 91, 95
Bill :	10 (2), 10.5, —, 11 (2), 11.5.	10 (2), 10.5 (3), 11 (2)

Vaurie (1951b, pp. 28-34) had reported on a part of the abovementioned collection.

[**Hirundo fluvicola** Blyth. Indian Cliff Swallow.

Although Nepal is generally included in the range of the Indian Cliff Swallow (Baker, 1926, p. 247 ; Vaurie, 1959a, p. 14 ; Peters, 1960, p. 122, but *not* Ripley, in press), there does not seem to be any authentic record of its occurrence there. The nearest I can trace is Sharpe's (1885, p. 201) listing of a single Hodgson specimen from ' Behar '.]

*352. **Delichon nipalensis nipalensis** Horsfield & Moore. Nepal House Martin.

The only post-Hodgsonian records of the Nepal House Martin are Stevens's (1925a, p. 375) from the Mai Valley, eastern Nepal, at *c.* 2440 m. in late April, and Biswas's (1960a) from eastern Nepal at *c.* 1525 m. in June.

Family MOTACILLIDAE

353. **Motacilla flava beema** (Sykes). Indian Blueheaded Wagtail.

NEPAL VALLEY : Thankot : 1 ♂ (April 12).

The Blueheaded Wagtail was rarely seen by us in central Nepal. We came across it a few times when it was found to occur in small flocks (4-6 individuals) in hill streams around Thankot in early April, and a pair was once seen on the edge of water in an open drain in Kathmandu on April 25.

Scully (1879) and Ripley (1950b) did not record it. Proud (1955, p. 68) found it in the Nepal Valley in winter, and Rand & Fleming (1957, p. 186) reported it in addition from the western and eastern tarai in winter.

Measurements : 1 ♂ : Wing 79 ; tail 69 ; bill 16.

354. **Motacilla flava thunbergi** Billberg. Greyheaded Wagtail.

Proud (1955, p. 68) is responsible for the only record of the Greyheaded Wagtail from Nepal. She obtained specimens in the Nepal Valley and reported its occurrence also in the eastern tarai on passage in spring.

*355. **Motacilla flava melanogrisea** (Homeyer). Turkestan Blackheaded Wagtail.

This wagtail has so far been reported from Nepal only once and that was by Rand & Fleming (1957, p. 186) from cut-over rice fields in the lowlands of western Nepal in December.

*356. **Motacilla citreola citreola** Pallas. Yellowheaded Wagtail.

The only record of the Yellowheaded Wagtail from Nepal has been made by Rand & Fleming (1957, p. 187) from the western and eastern tarai in winter.

357. **Motacilla citreola calcarata** Hodgson. Hodgson's Yellowheaded Wagtail.

NEPAL VALLEY : Thankot : 1 ♂ (April 12).

This Yellowheaded Wagtail was observed by us only once in a swampy patch at Thankot when the abovementioned specimen was collected. It is apparently a rare bird of central Nepal. Scully's (1879, p. 316) only record was a probable sight record; Ripley (1950b) did not find it; and Proud (1955, p. 68) reported it as a passage migrant in the Nepal Valley, a few remaining there for the winter. Rand & Fleming (1957, p. 187) record it from the western lowlands as fairly common in winter.

Measurements : 1 ♂ : Wing 88 ; tail 84; bill 18.

The measurements as given by Baker (1926, p. 274) for this bird are inaccurate.

358. **Motacilla cinerea cinerea** Tunstall. Eastern Grey Wagtail.

BHABAR : Amlekhganj : 2 ♀♀ (March 7). CHITLANG VALLEY : Chitlang : 1 unsexed (April 17). NEPAL VALLEY : Thankot : 6 ♂♂, 3 ♀♀ (March 24, April 5-13).

The Eastern Grey Wagtail is a common bird about streams and tanks on the edges of forests in Nepal.

Scully (1879, pp. 315-316) found it common in the Nepal and Markhu valleys and Nawakot district in winter. Ripley (1950b, p. 381) noted it in the tarai and the Nepal Valley. Polunin (1955, p. 894) recorded it in the Langtang Valley, central Nepal, at *c.* 3505 m. and 4115 m. in summer. Lowndes (1955, pp. 34-35) observed it in Manangbhot, central Nepal, from *c.* 2135 to 4115 m. in summer. Rand & Fleming (1957, p. 186) reported it in west-central and central Nepal from the tarai up to *c.* 1980 m. during winter and spring.

A female specimen (Thankot, March 24) has the chin and throat in moult, while another female from the same locality (April 10) has some of its rectrices still growing.

Measurements :

	Wing	Tail	Bill
6 ♂♂ :	82 (3), 83 (2), 84	92 (2), 93 (2), 96, 98	16, —(2), 17 (3)
5 ♀♀ :	80, 81, 82 (2), 84	92 (2), —, 93, 97	16 (2), 17 (2), 17.5
1 unsexed :	82	91	—

The measurements of tail and tarsus as given by Baker (1926, pp. 265-266) are evidently incorrect.

Vaurie (1957a, p. 10) has shown that both *caspica* Gmelin and *melanope* Pallas should be synonymized with nominate *cinerea*.

Motacilla alba Linnaeus

Six races of the White Wagtail group have so far been recorded from Nepal, and all of them from central Nepal. Curiously, Ripley (1950b) did not report any.

359. **Motacilla alba dukhunensis** Sykes. Indian White Wagtail.

Nepal Valley : Thankot : 3 ♂♂ (April 12).

This White Wagtail is fairly common in the Nepal Valley during April on rivers, in paddy or wheat fields, etc.

Scully (1879, pp. 314-315) and Proud (1955, p. 67) reported it to be common in the Nepal Valley throughout the winter up to May. Rand & Fleming (1957, p. 185) found it from western to eastern Nepal at *c*. 275-1340 m. between November and April. Biswas (1960a) reported it from Chautara district, central Nepal, at *c*. 855 m. in January.

Measurements : 3 ♂♂ : Wing 90 (2), 91 ; tail 90, 91 (2) ; bill 17, —, 18.

*360. **Motacilla alba personata** Gould. Masked Wagtail.

Lowndes (1955, p. 35) reported the Masked Wagtail for the first time from Nepal. He came across it in Manangbhot, central Nepal, at *c*. 3505 m. in July. Proud (1955, p. 67) found it as a very rare winter visitor to the Nepal Valley. Rand & Fleming (1957, p. 185) recorded it from the western and eastern tarai in winter.

361. **Motacilla alba baicalensis** Swinhoe. Swinhoe's White Wagtail.

Nepal Valley : Kathmandu : 1 ♂ (April 8).

This wagtail appeared rare in central Nepal during March-April. The specimen mentioned above was found on Bagmati River in a mixed flock of *M. a. alboides* and *M. a. leucopsis*. None of Hodgson's or Scully's specimens is *baicalensis* ; nor do their lists contain it (it was, however, not recognized during Hodgson's time), and Ripley (1950b), and Rand & Fleming (1957) did not record it either. The only other specimen of this race from Nepal that I could find was one in the Bailey collection in the British Museum, labelled as *leucopsis*. Polunin

(1955, p. 894) reported it from the Langtang Valley, central Nepal, in summer. Proud (1955, pp. 67-68) found it on passage in the Nepal Valley in spring, a few examples remaining there in winter.

My specimen had non-breeding testes.

Measurements : 1 ♂ : Wing 93 ; tail 92 ; bill 17.

362. **Motacilla alba ocularis** Swinhoe. Streakeyed Wagtail.

NEPAL VALLEY : Kathmandu : 1 ♂ (April 25).

The Streakeyed Wagtail was observed by us along Bagmati River in very small numbers for about 10 days from mid-April. It was seen in mixed flocks with *M. a. dukhunensis.* Scully (1879, p. 315) was the first to report its occurrence in Nepal. He obtained a single example in the Nepal Valley on May 7. Subsequently, it was observed only by Proud (1955, p. 67) as common there on spring migration.

My specimen had non-breeding testes.

Measurements : 1 ♂ : Wing 97 ; tail 99 ; bill 16.

363. **Motacilla alba leucopsis** Gould. Whitefaced Wagtail.

NEPAL VALLEY: Kathmandu, Thankot: 7 ♂♂, 6 ♀♀ (March 21, 23, April 8-12).

The Whitefaced Wagtail was found by us to be quite common in the Nepal Valley during March-April on sandy banks and sandy islands of rivers, frequently in mixed flocks with *M. a. alboides.*

Scully (1879, p. 314) found it common in winter from the Nepal Valley down to the central plains. Proud (1949, p. 712 ; 1955, p. 68) reported it extremely common in the Nepal Valley in winter. Rand & Fleming (1957) did not include it in their list.

All my specimens had non-breeding gonads.

Measurements :

	Wing	Tail	Bill
7 ♂♂ :	87, 88 (2), 89 (2), 91 (2)	85, 86, 89 (2), 90 (2), 91	17 (4), 17.5, 18 (2)
6 ♀♀ :	85, 86, 87, 88, 89, 90	86 (3), 87, 92 (2)	17 (4), 17.5 (2)

364. **Motacilla alba alboides** Hodgson. Hodgson's White Wagtail.

BHABAR: Amlekhganj: 1 ♂ (March 8). NEPAL VALLEY: Kathmandu, Thankot : 6 ♂♂, 5 ♀♀, 1 unsexed (March 23, 24, April 9-14).

Hodgson's White Wagtail is quite a common bird of the Nepal Valley during March-April, usually at the same sites as *M. a. leucopsis,* sometimes in mixed flocks with it. On a few occasions it has also been seen roving over cultivated fields on river banks.

Lowndes (1955, p. 35) did not find it common in Manangbhot, *c.* 3655 m., central Nepal, in summer. Rand & Fleming (1957, p. 184) recorded it from west-central to eastern Nepal (*c.* 290-2745 m.) in winter. Biswas (1960a) reported it from eastern Nepal at *c.* 855-2135 m. in January-February, and *c.* 3960-4570 m. in March-May.

All my examples had non-breeding gonads.

My female specimens are blackish grey on the upper side.

Measurements :

	Wing	Tail	Bill
7 ♂♂ :	90, 93, 94 (2), 95, 96, 97	90, 91 (2), 93, 94, 95, 97	18 (2), 18.5, 19 (4)
5 ♀♀ :	87 (3), 88 (2)	86 (3), 88 (2)	18 (2), 18.5, 19,—
1 unsexed :	94	92	19

365. **Motacilla maderaspatensis** Gmelin. Large Pied Wagtail.

BHABAR : Amlekhganj : 1 subad. ♂ (June 8). DUN: Hitaura : 3 subad. ♂♂, 5 juv. ♂♂, 7 subad. ♀♀ (May 15, 16, 27, June 2, 12, 24, July 11, 18). MARKHU VALLEY : Kulikhani : 1 ♂ (July 2). NEPAL VALLEY : Thankot : 2 subad. ♂♂, 1 subad. ♀ (April 10-12).

This pied wagtail is not a common bird of the Nepal Valley during March-May, but fairly common along the principal rivers of the central bhabar and dun in summer. Several times it was seen far away from rivers on other bodies of water.

Scully (1879) did not record the species from Nepal. Proud (1949, p. 712) found it very scarce in the Nepal Valley where Ripley (1950b, p. 381) found it in December. Rand & Fleming (1957, p. 184) reported it from the lowlands and foothills of west-central and central Nepal in winter and spring.

All the specimens marked subadult are not in full adult plumage. They have nearly completed post-juvenile moult. This moult has just started in three male specimens (Hitaura, June 12, 17, 22). Another male bird (Thankot, April 12) has nearly attained the adult dress, while the male specimen from Kulikhani (July 2) has just attained the adult plumage, although its outer and two central pairs of rectrices are still growing.

Measurements of adult and subadult birds :

	Wing	Tail	Bill
4 ♂♂ :	91, 92, 93, 96	93, 94,—, 98	19 (2), 20 (2)
7 ♀♀ :	88, 89, 90 (2),—,91 (2)	90 (2),—(2), 91 (2), 95	19 (2), 19.5 (4),—

*366. **Anthus novaeseelandiae richardi** Vieillot. Richard's Pipit.

Scully (1879, pp. 316-317) had a single female specimen of Richard's Pipit from the Nepal Valley in winter. He noted it as ' decidedly rare'. Later, Rand & Fleming (1957, p. 188) recorded it only from the eastern tarai in winter. There does not appear to be any other Nepali record of this pipit after Hodgson's.

367. **Anthus novaeseelandiae rufulus** Vieillot. Indian Pipit.

DUN : Hitaura, Bhimphedi : 1 juv. ♂, 2 ♀♀, 2 juv. unsexed (May 8, June 3, 4, 12, 19). NEPAL VALLEY : Burhanilkantha, Kathmandu, Thankot : 13 ♂♂, 1 juv. ♂, 1 subad. ♀ (April 1-14, May 3).

The Indian Pipit is common in central Nepal, from the dun up to the Nepal Valley in and about grasslands, and cultivated fields of wheat, maize, etc.

Scully (1879, p. 317) reported it resident in the Nepal Valley, and common in the Markhu Valley and Nawakot district in winter. Ripley (1950b, p. 381) found it in the Valley in April (breeding) and in the central plains in November. Rand & Fleming (1957, p. 188) noted it from western to eastern Nepal (*c.* 275-1065 m.) in winter.

The subadult female specimen (Burhanilkantha, May 3) is in very fresh plumage, immediately after a general moult. The blackish-brown centres of feathers of its upper parts and tail are somewhat darker than those of adult birds, and with broader and more prominent pale fulvous edges. Underparts are similar to adults. Hindclaw is a little shorter. It had non-breeding ovary.

Birds taken in April and May had fully breeding gonads, while a female taken on June 12, had exhausted ovary. The June 12 female is very worn.

Colours of soft parts : Iris brown to dark brown; upper mandible dark horny, paler on edges and tip; lower mandible fleshy with yellowish tinge on base and smoky on tip (the subadult female specimen lacks yellow); legs and feet yellowish fleshy (the subadult female has yellow only on the dorsal side); claws horny; pads pale yellow (white in subadult female).

Measurements :

	13 ♂♂	2 ♀♀	1 subad. ♀
Wing :	79.5, 81 (3), 82 (3), 82.5 (2), 83 (2), 84 (2)	76+, 78	80.5
Tail :	55, 57 (2), 58 (3), 59 (2), 59.5, 60, 62 (2), 63	55+, 60	59
Bill :	16 (2), 16.5 (4), 17 (5), 17.5 (2)	16, 17	15.5

*368. **Anthus godlewskii** (Taczanowski). Blyth's Pipit.

Polunin (1955, p. 894) provided the first authentic post-Hodgsonian record of this pipit from Nepal. He found a few specimens in the Langtang Valley, central Nepal, at *c.* 4115 m. early in September.

Proud's (1949, p. 712) report of the extra-limital *Anthus campestris*[1] from the Nepal Valley, refers in all probability to this species with which until recently, there has been a great deal of confusion (see Hall, 1957, pp. 726-731).

*369. **Anthus similis jerdoni** (Finsch). Brown Rock Pipit.

The only record of the Brown Rock Pipit from Nepal appears to be that of Rand & Fleming (1957, pp. 188-189) who occasionally found it in western Nepal near cultivation in winter.

370. **Anthus trivialis trivialis** Linnaeus. Tree Pipit.

NEPAL VALLEY : Thankot : 1 ♀ (April 11).

The Tree Pipit is apparently a rare bird in Nepal. Neither Hodgson (Gray & Gray 1846; Gray 1863), nor Scully (1879) or Ripley (1950b) found it there, but Rand & Fleming (1957, p. 187) record a single female specimen from west-central Nepal (*c.* 1370 m.) in December.

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[1] We have a recent letter from Mrs. Proud stating that this was an error and she never found this species in Nepal.— EDS.

My specimen was taken out of a flock of seven birds.

Measurements : 1 ♀ : Wing 83 ; tail 62 ; bill 15.5.

Anthus hodgsoni Richmond. Indian Tree Pipit.

The Indian Tree Pipit is a very common bird of central Nepal from Bhimphedi region to the Nepal Valley during March-April in gardens, light forests, outskirts of and clearings in forests. They usually occur in small flocks, individuals feeding together in a small patch of ground or scattered over a wide area. During the third week of April, however, one flock was found broken up into feeding pairs.

While I have not made any special study of this pipit, I find that the latest and the best available revision of the species by Ripley (1948b), has only limited utility by not answering many points. His characterization of the subspecies does not hold good in many cases. The striations particularly are very variable, and I have examined many specimens which, according to his definition, should be called *hodgsoni* when their dorsal side alone is examined, but *yunnanensis* from the ventral side. I believe, the question of the subspecies of *Anthus hodgsoni* still remains open.

I am not sure if the 33 specimens from Nepal at my disposal should all be placed under one subspecies or more. On the basis of characters of the dorsal side alone, as given by Ripley, they may, however, be grouped under the two[1] subspecies that are known to occur in India, as follows :

371. **Anthus hodgsoni yunnanensis** Uchida & Kuroda. Northern Tree Pipit.

TARAI : Simra : 1 ♀ (March 4). CHITLANG VALLEY : Chitlang : 1 ♀ (April 19). NEPAL VALLEY : Kathmandu, Pashupatinath, Thankot : 4 ♂♂, 6 ♀♀, 1 unsexed (March 21-April 17).

Ripley (1950b, p. 381) reported this form from western central and eastern Nepal at *c.* 1220-2440 m. in winter and spring. Rand & Fleming (1957, p. 187) found it from western to eastern Nepal at *c.* 275-2775 m. in winter.

Most of my specimens are in some stage of moult, e.g.:

March 4, ♀ : crown and throat
21, ♂ : crown, chin, throat and tail
22, ♂ : crown, chin and throat ; tail moult finished
23, ♂ : crown to nape and chin to upper breast
27, ♀ : crown
30, ♂ : posterior crown with just grown feathers ; central rectrices in moult
30, ♀ : whole head and chin to upper breast

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[1] There appears to be no authentic record of the occurrence of the third accepted subspecies, *A. h. berezowskii* Zarudny in India. Ripley's (op. cit., pp. 623, 626) record, followed by Vaurie (1959a, p. 68), is based on three specimens in the Koelz collection from Uttar Pradesh (United Provinces) that are in fact juvenile *Anthus pelopus.*

April 1, ♀ : crown, chin and throat
8, ♀ : crown to upper back, and chin to upper breast
11, ♀ : upper tail coverts

The gonads of a male (March 23) and two female (April 8 and 11) specimens were just beginning to swell.

Colours of soft parts : Iris dark brown ; upper mandible horny with fleshy on base ; lower mandible fleshy with horny tip ; legs and feet horny fleshy ; claws horny ; pads fleshy white.

Measurements :

	4♂♂	8♀♀	1 unsexed
Wing :	85 (2), 87, 87.5	79, 80 (2), 81 (2). 82 (2), 83	84
Tail :	64, 64+, 66, 66+	58, 59 (3), 61 (2), 62 (2)	62
Bill :	15 (3), 16	15 (6), 16 (2)	—

372. **Anthus hodgsoni hodgsoni** Richmond. Hodgson's Tree Pipit.

BHABAR : Amlekhganj : 1 ♂ (March 7). DUN : Bhimphedi : 1 ♂, 1 ♀ (March 11, 12). CHITLANG VALLEY : Chitlang : 2 ♂♂ (April 19, 20). NEPAL VALLEY : Kathmandu, Pashupatinath, Gowchar, Thankot, Chandragiri Pass : 8♂♂, 5♀♀, 2 unsexed (March 20-April 13).

Ripley (1950b, p. 381) found this Tree Pipit only in eastern Nepal in winter, and Rand & Fleming (1957) did not find it at all.

Some of my specimens are in moult, e.g. :

March 7, ♂ : moult just commenced on throat.
11, ♂ : crown, throat and tail.
20, ♀ : crown to upper back, and chin to breast
24, unsexed : crown to nape, and chin to upper breast
26, ♂ : whole head, chin, throat
26, ♂ : just commenced on chin and throat

April 1, ♂ : moult just finished
5, ♂ : head feathers still with sheaths
5, ♀ : crown to back, and chin to breast
10, unsexed : throat in moult, tail very worn
12, ♂ : moult just finished
13, ♂ : sheaths still present on feathers of crown to upper back, and chin to throat
19, ♂ : posterior crown
20, ♂ : crown

All the specimens had non-breeding gonads.

Measurements :

	12 ♂♂	6 ♀♀	2 unsexed
Wing :	83 (2), 84, 85, 85.5, 86 (3), 87 (3), 90[a]	80, 81 (2), 82 (2), 82.5	81, 84
Tail :	59, 62 (4), 63 (2), 64 (2), 65.5, 66, 68[a]	58, 59, 60 (2), 62 (2)	—, 60
Bill :	15 (4), 15.5 (2), 16 (3), —, 16[a], 17	15 (3), 15.5 (3)	15.5 (2)

[a] This, the largest specimen (Chitlang, April 19), also has the striations on the upper side intermediate between *yunnanensis* and *hodgsoni*.

* 373. **Anthus cervinus** (Pallas). Redthroated Pipit.

The only post-Hodgsonian record of the Redthroated Pipit from Nepal has been furnished by Rand & Fleming (1957, p. 188) who took a single example in west-central Nepal at *c*. 5180 m. in December.

374. **Anthus pelopus** J. E. & G. R. Gray. Hodgson's Pipit.

Anthus pelopus J. E. & G. R. Gray, 1846, Cat. spec. drawings Mam. Birds Nepal pres. Hodgson, p. 154. (Nepal.)

A. (*nthus*) *roseatus* Blyth, 1847, *J. Asiat. Soc. Beng.* **16** : 437. (Nepal.)

NEPAL VALLEY : Thankot : 5 ♂♂, 1 ♀ (April 9-12).

We did not find Hodgson's Pipit to be common in central Nepal. Small flocks were occasionally seen in wet fields and grassy patches.

Scully (1879, pp. 317-318), found it to be fairly common in the Nepal and Chitlang valleys, central Nepal, from October to March, but always solitary. Ripley (1950b) did not find it in Nepal. Polunin (1955, p. 894) reported it as very common at *c*. 3050 m. up in the Langtang Valley, central Nepal, during summer. Lowndes (1955, p. 35) found it locally fairly common in summer up to *c*. 4725 m. in Manangbhot, central Nepal. Biswas (1960a) reported it breeding at *c*. 4570-4725 m. in April-May and observed it commonly up to *c*. 5335 m. in May in Khumbu, eastern Nepal.

A male specimen taken on April 10 is undergoing post-juvenile moult.

Measurements :

	Wing	Tail	Bill
4 ♂♂ :	84.5 [a], 86.5[a], 90, 91	63[a], 64[a], 67, 69	16[a], —, 17[a], 17
1 ♀ :	85	64	16.5

[a] These two specimens appear to be female from size, but they are marked male on their labels.

375. **Anthus sylvanus** (Blyth). Upland Pipit.

MARKHU VALLEY : Deorali : 1 ♂ (April 29). CHITLANG VALLEY : Chitlang : 4 ♂♂, 1 ♀ (April 29, July 2, 26).

This pipit was occasionally found by us on the Chandragiri above Chitlang and on the Mahabharat Range around Deorali.

Scully (1879, p. 318) and Proud (1949, p. 712) found it resident on hills round the Nepal Valley. Polunin (1955, p. 895) reported a single example in the Langtang Valley, central Nepal, at *c*. 2745 m. in summer. Ripley (1950b) did not find it in Nepal. Rand & Fleming (1957, p. 189) record it from west-central Nepal at *c*. 1435 and 2285 m. in winter.

It was breeding in July.

Measurements :

	Wing	Tail	Bill
5 ♂♂ :	78, 79 (2), 80 (2)	66, 69, 70 (3)	17.5, —, 18 (3)
1 ♀ :	79	69	18

Family CAMPEPHAGIDAE

376. **Coracina novaehollandiae nipalensis** (Hodgson). Large Himalayan Cuckoo-Shrike.

TARAI : Simra : 2 ♂♂ (March 5, 6), BHABAR : Amlekhganj : 1♂, 1 ♀ (March 9, 10). DUN : Hitaura : 1 ♂, 1 subad. ♂, 3 ♀♀ (May 22, 28, June 1, 9, 15). NEPAL VALLEY : Godavari, crest of Chandragiri above Thankot : 1 ♂, 3 ♀♀ (April 14, May 10, 15).

This large cuckoo-shrike is a common bird of different types of forests of central Nepal, usually in pairs at least during spring and summer. It is shy.

Scully (1879, p. 268) found it common in Nawakot district and the central bhabar and dun in winter, but merely as a straggler in the Nepal Valley from end October to mid-November. Proud (1949, p. 707), however, reported it to be resident there from *c.* 1525 to 2440 m., and saw it even in January and February. Ripley (1950b, p. 383) came across it from the tarai up to *c.* 1830 m. Rand & Fleming (1957, p. 104) reported it from *c.* 275 to 1830 m. in western through eastern Nepal.

The subadult male specimen (Hitaura, June 1) is moulting into adult dress. A female bird (Godavari, May 10) has the forecrown and upper breast moulting. Two other birds (Hitaura, ♀, May 22, and ♂, June 15) are also in partial moult, while another female (Hitaura, June 9) is finishing a complete moult.

In mid-April a female had granular ovary, measuring 10 × 6 mm., while in mid-May birds had almost breeding gonads, but females taken on May 28 and June 9 had spent up ovaries.

Colours of soft parts : Iris brownish red ; bill, legs, feet and claws black ; pads grey or yellowish grey.

Measurements :

	Wing	Tail	Bill
5 ♂♂ :	175, 176, 180, 181, 187	132, 135, 136, 143, 148	31(2), 32, 32.5, 33
6 ♀♀ :	173, 177 (2), 178, 179, 180	133, 138, 141, 142 (2), 143	31 (3), 31.5 (2), 32

377. **Coracina melaschistos melaschistos** (Hodgson). Dark Grey Cuckoo-Shrike.

TARAI : Simra : 1 ♀ (March 6). DUN : Hitaura, Kusumtar, Bhimphedi : 1 subad. ♂, 2 ♀♀ (May 6, 19, 31). MARKHU VALLEY : Deorali : 1 ♂ (May 1). CHITLANG VALLEY : Chitlang : 1 subad. ♂ (April 16). NEPAL VALLEY : Thankot : 7 ♂♂, 3 ♀♀, 2 subad. ♀♀, 1 juv. ♀ (March 21-29, April 1, 14, June 29).

This smaller cuckoo-shrike is common in the Nepal Valley from about the third week of March. It is common also in the dun during May-June. Rand & Fleming (1957, p. 104) did not find it to be common in the Nepal Valley. However, it was very frequently heard and as a matter of fact, observed by us in fair numbers on the slopes of Chandragiri about Thankot, also at Godavari and in smaller numbers in the central woods.

Scully (1879, p. 267) noted it in the Nepal Valley from April to September, while Proud (1949, p. 707) found it there from March to mid-October. Ripley (1950b, p. 382) found it in the eastern tarai in winter. Rand & Fleming (loc. cit.) recorded it from west-central Nepal also.

A subadult female bird from Thankot (April 1) has the primaries brown. The subadult male from Chitlang (April 16) has brown primaries and some bars on the undertail coverts, while another subadult male (Hitaura, May 19) has brownish general coloration with brown primaries and rectrices. The juvenile female specimen (Thankot, June 29) is barred both above and below.

Birds taken towards the end of March (28-29) had somewhat swollen gonads, the ovaries being granular, and a female shot two months later (Hitaura, May 31) had much developed ovary, measuring 7 × 8 mm. with a few ova 3-4 mm. in diameter.

Colours of soft parts : Iris reddish brown ; bill, legs, feet and claws black ; pads dirty white, sometimes with yellowish tinge.

Measurements :

	8 ♂♂	6 ♀♀
Wing :	119, 121 (3), 124, 125, 127, 128	114, 117, 118 (2), 120, 122
Tail :	114, 117, 119, 120 (3), 121, 123	109, 110, 111,—, 118, 120
Bill :	20.5, 21, 21.5 (2), 22 (3), 23	21 (3), 21.5, 22, —

378. **Coracina melanoptera sykesi** (Strickland). Blackheaded Cuckoo-Shrike.

Lalage sykesi Strickland, 1844, *Ann. Mag. nat. Hist.* **13** : 36. (Deccan[1].)
DUN : Hitaura : 1 ♂ (May 21).

The Blackheaded Cuckoo-Shrike was seen by us only once in a patch of light forest bordering cultivated fields in the central dun. There does not appear to be any record of this species so far from Nepal.

Measurements : 1 ♂ : Wing 106 ; tail 94.

Delacour (1951, p. 14) has included this specimen in his studies on this species.

*379. **Pericrocotus roseus roseus** (Vieillot). Rosy Minivet.

The Rosy Minivet does not seem to have been reported from Nepal after Hodgson.

*380. **Pericrocotus cinnamomeus peregrinus** (Linnaeus). Northern Small Minivet.

We had not been lucky enough to come across the Small Minivet in Nepal, nor was Scully (1879) either. However, Ripley (1950b,

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[1] Strickland referred to Sykes's bird from the Deccan. Baker's (1921b, p. 696 ; 1924, p. 240 ; 1930a, p. 158) designation of the type locality as 'Calcutta' was therefore an error.

p. 382) found it in the western and eastern tarai, and Rand & Fleming (1957, p. 102) reported it from the western and west-central tarai.

381. **Pericrocotus solaris solaris** Blyth. Yellowthroated Minivet.

MARKHU VALLEY : Deorali : 1 ♂, 1 ♀ (April 29, 30).

The Yellowthroated Minivet was observed by us on two or three occasions in the oak forest about Deorali towards the end of April and early May. It was in all probability breeding around there. I am unable to find any other post-Hodgsonian record of its occurrence in Nepal.

Measurements :

	Wing	Tail	Bill
1 ♂ :	86	102	16
1 ♀ :	81	92	15

382. **Pericrocotus ethologus favillaceus** Bangs & Phillips. Western Longtailed Minivet.

383. **Pericrocotus ethologus laetus** Mayr. Sikkim Longtailed Minivet.

DUN : Bhimphedi : 1 ♂, 1 ♀ (March 13, May 7). CHITLANG VALLEY : Chitlang, Chandragiri above Chitlang : 2 ♂♂, 1 ♀ (April 18-24). NEPAL VALLEY : Thankot, Chandragiri above Thankot : 3 ♂♂, 1 juv. ♂, 4 ♀♀, 1 juv. ♀ (March 24-April 13).

The Longtailed Minivet is quite common from Bhimphedi up to the Nepal Valley, particularly in the forests at the foot of Chandragiri, both on Thankot side and on Chitlang side. On some occasions we observed it passing in a flock from one side of the range to the other across the crest. This crossing would be done rather leisurely, the birds stopping several times on the way to feed or indulge in love-play.

Ripley (1950b, pp. 381-382) reported it from western and eastern Nepal also. Lowndes (1955, p. 33) found it in Manangbhot, central Nepal, occasionally at *c.* 3655-3930 m. in summer. Rand & Fleming (1957, p. 102) recorded it from western to eastern Nepal.

On March 24, a male bird had quite enlarged testes, 10 × 6 (R) and 11 × 7 mm. (L), and a female on April 9 was laying ; but another female on April 13 had only granular ovary, 5 × 3 mm.

Measurements :

	Wing	Tail	Bill
6 ♂♂ :	89, 91, 92 (2), 92.5, 94	102, 103 (2), 103.5, 104, —	15.5 (2), 16 (2), 16.5—
6 ♀♀ :	89 (2), 89.5, 90, 91, 92	101.5, 102 (2), 103, 107, 108	15.5 (2), 16.5, — (3)

Scully (1879, pp. 268-270) listed all his specimens of *P. ethologus* under the closely similar species *P. brevirostris.* Those of his specimens that I have examined, undoubtedly belong to *P. ethologus.* Furthermore, his description and measurements also bear this out. Ripley (loc. cit.)

called his eastern Nepal examples *laetus*, and the central and western ones, *favillaceus*, while Rand & Fleming (loc. cit.) placed all their examples from western, west-central and eastern Nepal under *favillaceus*. Lowndes (loc. cit.) identified his specimens from the westernmost part of central Nepal as *laetus*. From an examination of the collections at the British and American Museums of Natural History, however, I am unable to subscribe fully to their views. All my female specimens have reduced yellow on forehead, thus approaching *laetus*, but olive green on the back is not pronounced, thereby leaning towards *favillaceus*. Moreover, the wing-tail ratio in the males is closer to that of *laetus*. I would, therefore, treat the central Nepal population as intermediate between the western Himalayan *favillaceus* and the eastern *laetus* with perhaps a slight leaning towards the latter. The intergrading zone extends eastward at least up to the Dudh Kosi Valley, for the single specimen examined thence appears near *favillaceus*. I have not had the opportunity to compare any specimen from west-central or western Nepal, nor from east of the Dudh Kosi Valley. But from the data furnished by Ripley and Rand & Fleming, I would imagine the ranges of the two subspecies in Nepal to be as follows :

Western and west-central ..	*P. e. favillaceus.*
Central and eastern up to Dudh Kosi Valley ..	*P. e. favillaceus* ≷ *laetus*
Eastern, Arun Valley eastward ..	*P. e. laetus*

384. **Pericrocotus brevirostris brevirostris** (Vigors). Shortbilled Minivet.

MARKHU VALLEY : Deorali : 1♂, 1♀ (April 29, 30).

The Shortbilled Minivet did by no means appear to be common in central Nepal. A small flock was seen in the pine forest near Deorali when two specimens were collected. Very probably it breeds somewhere in central Nepal, for my specimens had much enlarged gonads, and in the flock the males were seen chasing the females.

Scully's birds listed under *P. brevirostris* are, as has been noted above, all *P. ethologus*. Ripley (1950b) did not come across *P. brevirostris* in Nepal, and Rand & Fleming (1957, p. 101) hesitantly placed an immature male specimen taken near Beni, west-central Nepal (November) under this species. The reports of this species by Proud (1949, p. 707) from the Nepal Valley, and Polunin (1955, p. 892) from the Langtang Valley, central Nepal, are based on sight records. My specimens would, therefore, constitute the first unmistakable record of the occurrence of the species west of Sikkim.

Measurements :

	Wing	Tail	Bill
1♂:	90	101	15.5
1♀:	89	95	15

385. **Pericrocotus flammeus speciosus** (Latham). Indian Scarlet Minivet.

TARAI : Simra : 2 ♂♂, 2 ♀♀ (March 4). BHABAR : Amlekhganj : 1 ♂, 2 ♀♀ (March 6-11). DUN : Hitaura, Bhimphedi : 6 ♂♂, 2 juv. ♂♂, 7 ♀♀ (May 7-June 1, 12). NEPAL VALLEY : Thankot : 1♂, 2 ♀♀ (March 23, April 1, 2).

The Scarlet Minivet is common in all the forests of central Nepal except those of the tarai, probably because it had already started moving to higher elevations by the time we arrived there in March. It has also been found in eastern Nepal by Ripley (1950b, p. 381) in February, and in western, west-central and eastern by Rand & Fleming (1957, p. 101) in November-February.

All my male specimens have the first two outer primaries unmarked and the females generally have three such unmarked feathers. The following variations in the female may be noted :

1. First two primaries unmarked (as in male) : Two specimens (Bhimphedi, May 7, and Hitaura, May 27).

The first-named specimen in this category has some faint scarlet patches on the under tail coverts. This incidentally is the largest of my female specimens.

2. First two primaries unmarked and the third primary with about 8 mm. long mark : One specimen (Amlekhganj, March 6).

3. Three left and two right primaries unmarked, the third right primary having only a small speck of yellow mark : One specimen (Hitaura, May 16).

The presence or extent of scarlet on the central tail feathers of males is somewhat variable. Of the 10 examples noted above, there is no scarlet on the central tail feathers in four of them, and in the remaining six specimens it is present as follows :

(1) As a small wedge on the tip : Two specimens : Simra, March 4 (8 and 11 mm.), Amlekhganj, March 11 (4 and 4.5 mm.).

(2) Spindle-shaped, not symmetrical on the two feathers : Three specimens :

  (i) Simra, March 4—on one : 52 mm. long, tip to about the middle of the feather, 4 mm. across the widest part, does not touch the shaft ; on the other : 37 mm. long, anterior end is at 15 mm. from tip of the feather, 1.5 mm. across the widest part.

  (ii) Thankot, April 1—similar to (i), but size 36 × 2.5 mm. and 45 × 3 mm. does not reach the tips of feathers.

  (iii) Hitaura, May 23—similar to (ii) but 55 × 3.5 mm.

(3) Irregular and asymmetrical : one specimen—Hitaura, May 16. On one central rectrix there is a 6 mm. wedge, but on the other it is as if a wedge has fused with a spindle-shaped mark (Fig. 1), 43 × 4 mm.

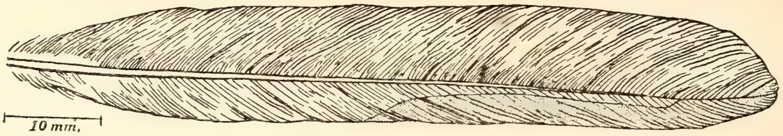

Fig. 1. Right central rectrix of a male specimen of *Pericrocotus flammeus speciosus* (Latham) from Hitaura, Nepal. The shaded area represents the irregular and asymmetrical scarlet patch.

A male on April 1 (Thankot) had much swollen testes, but the female of April 2 from the same locality had only granular ovary, 4 × 5 mm. End May—early June specimens had the testes about similar in size to those of April 1, but more enlarged ovaries.

Measurements :

	10 ♂♂	13 ♀♀
Wing :	100 (3), 102 (2), 103, 104 (3), 105	96, 97 (2), 97.5, 98 (2), 98.5, 99, 100, 101, 102, 102.5, 103[a]
Tail :	98, 99, 100 (2), 103, 104, 105 (4)	94, 96, 96.5, 98, 100 (3), 100.5, 102, 102.5, 103[a], 104, 105
Bill :	20 (4), 20.5 (2), 21 (2), 21.5 (2)	19, 19.5, 20 (4), 20.5, 21 (3), 21.5, 21.5[a], 22

[a] Specimen with the first two primaries unmarked, Bhimphedi, May 7 (also see above).

386. **Hemipus picatus capitalis** (Horsfield). Brownbacked Pied Shrike.

TARAI : Simra : 1 ♂, 1 ♀ (March 4, 6). BHABAR : Amlekhganj : 1 ♂, 1 ♀ (March 6, 7). DUN : Hitaura, Bhimphedi : 8 ♂♂, 1 subad. ♂, 3 ♀♀, 1 juv. ♀, 1 unsexed (May 4-6; 15, 24-29, June 7).

The Brownbacked Pied Shrike is commonly found in pairs or small parties in the denser parts of forests of the tarai, bhabar and dun of central Nepal. We were unable to locate it in the Nepal Valley, where Proud (1949, p. 707) found it but very rarely. Ripley (1950b, p. 382) recorded it from western and central Nepal up to *c.* 1525 m. in winter and spring. Rand & Fleming (1957, pp. 102-103) found it in west-central Nepal, *c.* 915-1400 m. in winter, and on the Chandragiri, *c.* 1830 m. central Nepal, in May.

The juvenile female (Hitaura, May 29) has the upper plumage barred with rufous, lower plumage white with fulvous tinge in irregular patches on throat, breast and abdomen ; wing coverts fulvous white barred with brown. Its crown feathers have an interesting colour pattern : a rufous bar on the tip, followed by a crescent of brown and the rest pale ashy with white shaft (Fig. 2).

The subadult male (Hitaura, May 24) is undergoing the post-juvenile moult.

The unsexed specimen (Bhimphedi, May 4) is very worn ; and an adult female (Hitaura, June 7) is in moult.

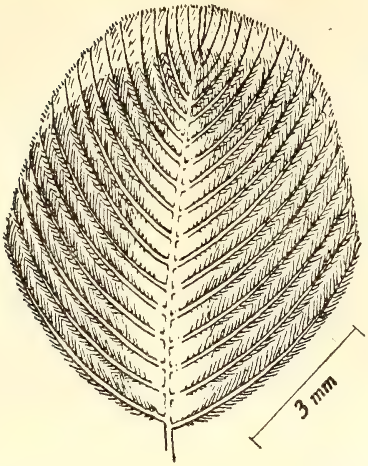

Fig. 2. A crown feather of a juvenile female specimen of *Hemipus picatus capitalis* (Horsfield) from Hitaura, Nepal. The apical bar is rufous, the shaft is white, the pale area adjacent to the shaft is pale ashy, and the remaining broad crescentic portion is brown.

Towards the end of May, the female birds had spent-up ovaries, and the males somewhat swollen testes ; breeding was evidently over.

Colours of soft parts : Iris brown (dark brown in juv. ♀); bill black; legs and feet dark horny (slaty in juv. ♀) ; claws black ; pads white.

Measurements :

	10 ♂♂	4 ♀♀
Wing :	62, 63 (2), 63.5, 64 (2), 64.5, 65 (2), 67	64 (2), 64.5 (2)
Tail :	59, 60, 61 (3), 62, 63, 64 (2), 65	61 (3), 63.5
Bill :	16, 16.5 (2), 17 (3), 17.5,— (3)	17 (3), 18

387. **Tephrodornis gularis pelvicus** Hodgson. Nepal Wood Shrike.

DUN : Kusumtar, Hitaura, Bhimphedi : 2 ♂♂, 7 subad. ♂♂, 2 juv. ♂♂, 3 ♀♀, 6 subad. ♀♀, 1 juv. ♀ (May 3-22, 31, June 3, 4, 16, July 15).

The Nepal Wood Shrike is common in the central dun. It usually occurs in pairs in open parts of forests.

Scully (1879) did not record the species from Nepal. Ripley (1950b, p. 382) found it in the tarai and dun. Rand & Fleming (1957, p. 103) reported it from the lowlands to *c.* 1065 m. of western, west-central and eastern Nepal.

All the subadult specimens which do not differ from adults in size, have somewhat barred secondaries and upper tail coverts, and two of them (♂, Kusumtar, May 31 and June 4) have some blotches of brown on ashy grey of crown, and white or mixed white and rufous tips of outermost rectrices (an adult ♀, June 4, also has white tips).

All the adult and subadult specimens are in worn plumage. One of the juvenile specimens (♂, May 19) is moulting into adult dress, while another (♀, July 15) is very young, with downy white feathers on the underside, evidently born during that season.

It does breed in subadult plumage. A subadult male had 13 mm. long testes on May 5. But towards the end of May and early in June, males had the testes reduced, and females had shrunken and exhausted ovaries.

Colours of soft parts : Iris yellowish brown (in one subad. ♂ almost reddish brown) ; upper mandible brownish black with brownish horny on base and round nostrils; lower mandible brownish horny, paler on base (in two subad. ♂♂ both mandibles black); legs and feet dull plumbeous (with horny tinge in a subad. ♂); claws black (horny in a subad. ♂) ; pads yellowish grey.

Measurements :

	Wing	Tail	Bill
2 ad. ♂♂ :	120, 123	90, 91	27.5 (2)
6 subad. ♂♂ :	119, 120 (3), 122 (2)	87 (3), 90 (3)	26, 27, —, 28, 28.5, 29
3 ad. ♀♀ :	—, 123 (2)	89, 90, 92	25.5 + , 27, 29
6 subad. ♀♀ :	116, 118 (2), 119, 120, 121	84, 86 (2), 87 (2), 88	—, 27.5 (2), 28, 28.5, 29

388. **Tephrodornis pondicerianus pondicerianus** (Gmelin). Common Indian Wood Shrike.

TARAI : Simra : 1 ♀ (March 4). DUN : Hitaura : 4 ♂♂, 1 ♀, 1 juv. ♀ (May 18, 23, June 1, 12).

The Common Wood Shrike is not uncommon in small flocks in light forests of the tarai and duns of central Nepal.

Ripley (1950b, p. 382) found it in the western tarai also, and Rand & Fleming (1957, p. 103), from *c.* 275-455 m. in western, west-central and eastern Nepal.

The March bird has the central rectrices in moult, and the other adult examples (May-June) are worn.

Measurements :

	Wing	Tail	Bill
4 ♂♂ :	86 (2), 87, 91	64, 68 (2), 69	23 (4)
2 ♀♀ :	86, 86.5	68, 71	23, —

FAMILY PYCNONOTIDAE

389. **Pycnonotus striatus striatus** (Blyth). Himalayan Striated Green Bulbul.

RAPTI VALLEY : Mahabharat Range above Bhimphedi : 1 ♂, 1 imm. ♂, 2 ♀♀ (May 4, 6). MARKHU VALLEY : Deorali : 1 ♂ (May 1). CHITLANG VALLEY : Chitlang : 1 ♂, 1 ♀ (April 16, 25). NEPAL VALLEY : Thankot : 5 ♂♂, 3 ♀♀ (March 30-April 8).

The Striated Green Bulbul is not uncommon in central Nepal. It was found by us in small flocks during March-April on both sides of Chandragiri above 1525 m., and in May on Mahabharat Range above Bhimphedi about the same altitude.

Scully (1879) did not include it in his Nepal list. Ripley (1950b, p. 385) reported it also from *c.* 2285 m. in eastern Nepal.

A male bird (April 25) from Chitlang has two outer rectrices still growing.

The immature male specimen (Bhimphedi, May 6) is smaller in size and has narrow, but not pointed tail feathers.

A female example taken on May 6 (Bhimphedi) was laying.

Measurements :

	Wing	Tail	Bill
8 ♂♂ :	106, 107 (2), 109 (2), 111, 112, 113	98, 99 (2), 100, 101, 102, 105, 106	20.5 (2), 21 (4), 21.5, 22
6 ♀♀ :	105 (3), 106, 107 (2)	97, 100 (2), 101, 103 (2)	20.5 (2), 21 (3), 21.5

390. **Pycnonotus melanicterus flaviventris** (Tickell). Blackcrested Yellow Bulbul.

TARAI : Simra : 3 ♂♂, 3 ♀♀ (March 4-7). DUN : Hitaura, Bhairab Thumka : 5 ♂♂, 3 ♀♀, 2 feathered chicks (May 16, 20, 30, June 1-6, 11).

The Blackcrested Yellow Bulbul is not uncommon in pairs in the tarai, bhabar and dun usually in light forests, but on one or two occasions was seen in fairly dense forests too.

Scully (1879, pp. 295-296) found it in the central bhabar in winter. Ripley (1950b, p. 384) reported it from tarai close to the foothills. Rand & Fleming (1957, pp. 144-145) found it from western to eastern Nepal *c.* 275-1065 m.

A male on June 1 (Hitaura) had somewhat swollen testes. The gonad of a female taken on the same day, however, was more advanced. Another male collected on June 11 had fully breeding testes.

Colours of soft parts : Iris pale yellow ; bill black ; legs and feet horny ; claws dark horny ; pads yellowish white.

Measurements :

	8 ♂♂	6 ♀♀
Wing :	86 +, 89, 90 (4), 91, 93	86 (2), 87 (2), 88, 89
Tail :	85 +, 86, 87, 88 (2), 89, 90 (2)	83, 84, 85 (3), 86
Bill :	16 (6), 16.5, 17	15.5 (2), 16 (2), 16.5 (2)

Deignan (1954a, p. 123) has shown that *Pycnonotus gularis, P. flaviventris, P. dispar* and *P. melanicterus* are all conspecific (*contra* Ripley, 1946, p. 228 ; 1950b, p. 384; and Rand & Fleming, 1957, pp. 144-145).

391. **Pycnonotus jocosus pyrrhotis** (Bonaparte). Northern Redwhiskered Bulbul.

I.(xos) pyrrhotis ' Hodgs.' Bonaparte, 1850, Consp. Gen. Av. **1**: 265. (India = Nepal, ex Hodgson, 1844, *nom. nud.*)

Otocompsa jocosa provincialis Whistler, 1931, *Bull. Brit. orn. Cl.* **52** : 40. (Kumaon Bhabar.)

DUN : Hitaura : 3 ♂♂, 3♀♀, 2 nestlings (May 12-27, June 9).

The Redwhiskered Bulbul is fairly common in the bhabar and dun of central Nepal during May-June in scrub jungle and light forests. It is usually found in small flocks, but pairs as well as mixed feeding parties of this species and *M. cafer* are also seen.

Scully (1879, p. 296) reported only caged specimens. Ripley (1950b) did not find it in Nepal. Rand & Fleming (1957, p. 145) reported it fairly common in the tarai and dun from western to eastern Nepal.

Almost all my adult examples are fairly worn. A female (May 17) has worn body plumage but fresh wings and tail.

One of the nestlings (May 12) has a dark brown crest and incomplete pectoral band, while the other specimen, taken June 9, is downy, with a few black feathers on crest and a complete pectoral band.

Measurements :

	Wing	Tail	Bill
3 ♂♂ :	88 + , 90 (2)	85, 85 + , 86	19 (2),—
3 ♀♀ :	80, 81, 83	73, 77 (2)	18·5 (2), 19

392. **Pycnonotus leucogenys leucogenys** (J. E. Gray). Indian White-cheeked Bulbul.

Brachypus leucogenys J. E. Gray, 1835, Illustr. Indian Zool. **2** : pl. 35, fig. 3. (India = Himalaya and in Kashmir, according to Blyth, 1845, p. 567 ; = Darjeeling according to Baker, 1921a, p. 469 ; = Kashmir according to Vaurie 1958, p. 19.)

TARAI : Simra : 2 ♂♂ (March 4). BHABAR : Amlekhganj : 2 ♂♂, 1 juv. ♀ (March 6, 8). DUN : Hitaura, Bhimphedi : 3 ♂♂, 1 juv. ♀, 1 unsexed juv. (March 11, May 6, 8, 25, 26). CHITLANG VALLEY : Chitlang : 2 ♀♀ (April 18, 22). NEPAL VALLEY : Sheopuri ridge (east of Burhanilkantha), Godavari, Thankot, Crest of Chandragiri 5 ♂♂, 5 ♀♀ (March 23-30, April 2-9, May 2, 10-13).

The Whitecheeked Bulbul is a very common bird of central Nepal from the bhabar up to the Nepal Valley. It was also reported from western and west-central Nepal, up to *c.* 2440 m. by Rand & Fleming (1957, p. 145), northern part of central Nepal (Langtang Valley, *c.* 2440 m.) by Polunin (1955, p. 889), and the Arun Valley (*c.* 1525 m.), eastern Nepal, by Biswas (1960a).

A female taken March 30 (Crest of Chandragiri) had swollen ovary, with ova as large as 2.75 and 2 mm., while another female collected at Thankot on April 2 had a granular ovary. Birds taken in May and June had full breeding gonads.

Colours of soft parts : Iris dark brown ; bill, legs, feet and claws black ; pads grey to white.

Measurements [1] *:*

	18 ♂♂	8 ♀♀	2 unsexed
Wing :	85,—, 86, 87, 88 (2), 89 (4), 90, 91 (3), 92 (3), 94	82, 83, 84 (2), 85 (3), 86	86, 88
Tail :	81, 82, 83 (3), 84, 85 (3),—(2), 86 (2), 87, 88 (2), 89, 90	80, 81 (2), 82, 84 (2), 85, 86	84, 85
Bill :	19 (3), 19.5 (5), 20 (6), 20.5 (2), 21,—	18.5 (4), 19 (4)	19, 19.5

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[1] Including those of some additional specimens from Nepal present in the Zoological Survey of India.

For a discussion as to whether the White-eared Bulbul, *P. leucotis*, should be considered conspecific with *P. leucogenys*, see Vaurie (1958, pp. 14-15 ; 1959a, p. 191) and Ripley (1958a, pp. 1-5 ; and in press).

393. **Pycnonotus cafer bengalensis** Blyth. Bengal Redvented Bulbul.

TARAI : Simra : 1 ♀ (March 4). DUN : Hitaura : 1 ♂, 1 juv. ♂, 2 ♀♀, 2 juv. ♀♀, 1 chick in down (May 19, 26, 27, June 4, July 28). CHITLANG VALLEY: : Chitlang : 3 ♂♂ (March 18, April 21, 24). NEPAL VALLEY : Kathmandu, Thankot : 4 ♂♂, 2 ♀♀ (March 21-24, 30, April 7, 9).

The Redvented Bulbul is a very common bird in central Nepal from the plains up to the Nepal Valley in and around villages. It has been reported from western and eastern Nepal by Ripley (1950b, p. 384), and Rand & Fleming (1957, pp. 145-146).

A male and a female bird taken on May 19 and 26 respectively, are not in full adult plumage : they have very brown primaries, but in size they are fully grown. The male specimen has the central rectrices in moult, but the female is worn. The juvenile female specimen of July 28 (Hitaura) has black feathers coming on the crown, throat and breast. The chick in down (Hitaura, May 27) has brown body with paler vent, and rufous on wing coverts and remiges.

A female taken on April 7 (Thankot) has just finished moult.

The gonads were already somewhat enlarged in the latter half of March and early April. Towards the end of May the gonads were in full breeding condition, and a female taken on June 4 had an exhausted ovary.

Colours of soft parts: Iris dark brown ; bill black ; legs, feet and claws very dark horny to black ; pads white.

Measurements :

	8 ♂♂	5 ♀♀
Wing :	101, 102, 103, 104 (2), 106 (2), 107	91, 96, 97, 98, 100
Tail :	95 +, 96+, 97, 98,99, 99+, 103, 103+	87 (2), 92, 93+, 95+
Bill :	20, 20.5, 21 (2), 21.5 (2), 22 (2)	19.5, 20, 20.5, 21.5 (2)

The sexual dimorphism of size in this species, already noted by earlier authors (e.g. Whistler & Kinnear, 1932b, pp. 775-756), is not apparent from the wing measurements given by Rand & Fleming (op. cit., p. 146).

394. **Cringer flaveolus flaveolus** (Gould). Indian Whitethroated Bulbul.

Trichophorus flaveolus Gould, 1836, *Proc. zool. Soc. Lond.* (4) : 6. (In Himalaya mountains, in Nepal, etc. [1], restricted to Nepal by Koelz, 1954, p. 10.)

DUN : Hitaura : 5 ♂♂, 6 ♀♀ (May 14-June 4).

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[1] Baker was obviously wrong in giving the type locality as '(India) (Cachar)' (1921a, p. 466 ; 1922d, p. 363) or as 'Himalayas, Cachar' (1930a, p. 75). His restriction cannot in any case stand, since Cachar is not in the Himalayas.

The Whitethroated Bulbul is not common in central Nepal. It was observed by us in small flocks in the forests around Hitaura in the dun, and was also seen once near Amlekhganj in the bhabar.

Scully (1879, p. 295) found it to be common in winter between the bhabar and dun, but Ripley (1950b) and Rand & Fleming (1957) did not report it from Nepal.

A female specimen (May 23) has moulting central rectrices, the left one being only half grown and the right one although apparently fully grown, had still the sheath on base.

Measurements :

	Wing	Tail	Bill
5 ♂♂ :	104, 105, 106 (2), 107	92, 93, 94 (2), 97	20, 21 (2), 21.5, 22
6 ♀♀ :	100 (3), 102, 103, 105	—, 88, 90 (2), 93 (2)	—(2), 21 (3), 21.5

395. **Hypsipetes virescens mcclellandii** (Horsfield). Rufousbellied Bulbul.

Hypsipetes mcclellandii Horsfield, 1839 (1840), *Proc. zool. Soc. Lond.* (7): 159. (Assam.)

Ixos mcclellandii vargus Koelz, 1954, Contr. Inst. Reg. Expl. (1) : 10. (Bhimphedi, Nepal.)

Dun : Hitaura, Bhimphedi : 6 ♂♂, 4 ♀♀, 1 unsexed (March 12, 13, May 6, 13, June 17, 18). Chitlang Valley : Chitlang : 2 ♂♂ (April 17, 20). Nepal Valley : Thankot : 8 ♂♂ (March 21-April 9).

The Rufousbellied Bulbul is common in central Nepal from the dun up to the Nepal Valley in pairs or in small parties. It was also found in western Nepal by Ripley (1950b, p. 385), and west-central Nepal by Rand & Fleming (1957, p. 146).

It was breeding in the forests of Bhimphedi during mid-June.

Colours of soft parts : Iris brownish red ; upper mandible very dark horny, a little paler on the sides of the anterior half; lower mandible fleshy with horny on base and tip ; legs, feet and claws dark horny ; pads rusty.

Measurements :

	16 ♂♂	4 ♀♀	1 unsexed
Wing :	100, 103 (2),—, 105 (3), 106, 107 (2), 108[a], 108 (2), 109 (2), 110	100, 102, 104, 107	109
Tail :	98 (2), 100 (2), 101 (2), 102 (3), 103[a], 105 (3), 107 (2), 109	99, 102, 104, 105	107
Bill :	25, 25[a], 26 (5), 26.5, 27 (2), —, 28 (4), 29	25, 26 (2), 27	26.5

[a] Type of *vargus* Koelz.

The measurements of tail and tarsus as given by Baker (1922d, p. 337), viz. 'about 110' and 'about 19' respectively, do not appear to be very accurate. Sixty-nine specimens taken from all over its range (Kumaon east to Manipur) measure :

	Tail	Tarsus
33 ♂♂ :	98-113 (av. 105.2)	16.5—19 (av. 17.4)
12 ♀♀ :	99-109 (av. 104.2)	16.5—18.5 (av. 17.8)
24 unsexed :	100-112 (av. 105.0)	16—18.5 (av. 17.3)

396. **Hypsipetes flavala flavala** (Blyth). Himalayan Brown-eared Bulbul.

Hemixos flavala Blyth, 1845, *J. Asiat. Soc. Beng.* **14**: 572. (' Sub-Himalayan ranges, extending to Assam, Sylhet and Arracan' = Nepal, ex Hodgson, MS. Hereby further restricted to Hitaura, Chisapani Garhi district.)

Dun : Hitaura, Bhimphedi : 11 ♂♂, 6 ♀♀, 2 unsexed (May 3-5, 11-29, June 5, 18).

The Brown-eared Bulbul is not uncommon in the central dun. It occurs in pairs in deeper forests. It was breeding in May-June.

Rand & Fleming (1957, p. 146) recorded it also from western and west-central Nepal, *c.* 305-1065 m.

Colours of soft parts: Iris brownish red; bill black; legs dark horny; feet horny; claws dark horny; pads white.

Measurements:

	11 ♂♂	6 ♀♀	2 unsexed
Wing:	95, 96, 97, 98[a], 98, 99 (3), 100 (2), 102	89, 93 (3), 94, 95	92, 98
Tail:	85, 87, 88[a], 88, 89 (3), 90, 91, 92, 95	81, 83 (2), 84, 85, 86	82, 88
Bill:	20, 20.5 (2), 21 (3), 21.5[a], 21.5 (3), 22	20 (6)	20, 21.5

[a] This specimen (Hitaura, May 14) has a rather long tarsus, 20 mm., against 19 ♂ ♀ : 17-18.5.

397. **Hypsipetes madagascariensis psaroides** (Vigors). Himalayan Black Bulbul.

Dun : Hitaura, Bhimphedi : 10 ♂♂, 7 ♀♀ (March 12, 13, May 3-11, 19, 25-28). Markhu Valley : Deorali : 3 ♂♂, 1 ♀ (April 29-May 2). Nepal Valley : Thankot : 1 ♂ (March 29).

The Black Bulbul is common in the dense forests of central Nepal from the dun to the Nepal Valley. In the latter place, however, it is not so common as it is in the dun. In May-June it was seen in small loose parties or a few pairs feeding together.

Ripley (1950b, p. 385) noted it as common in central and eastern Nepal, but did not see it in western Nepal. Polunin (1955, p. 889) reported it from *c.* 2440 m. in the Langtang Valley, central Nepal. Rand & Fleming (1957, p. 147) recorded it from western, west-central and eastern Nepal. Biswas (1960a) observed it in Chautara district, central Nepal and Ramechhāp district, western Nepal, in January-February.

Birds taken towards the end of May had breeding gonads.

Colours of soft parts: Iris dark brown; bill coral red; legs pale orange; feet deep orange; claws horny; pads white to pale orange.

Measurements:

	14 ♂♂	8 ♀♀
Wing:	116 (2), 121 (2), 122 (2), 123, 124 (3), 125 (2), 128, 129	111, 115 (3), 116 (2), 118 ,122
Tail:	102, 108, 109 (2), 110, 111 (2), 112 (4), 114, 116 (2)	97, 99, 100, 101, 105, 106, 110, 111
Bill:	26 (2), 27 (3), 27.5 (3),—, 28 (4), 29	26 (3), 27.5,—, 28 (3)

Family IRENIDAE

398. **Aegithina tiphia tiphia** (Linnaeus). Common Iora.

Dun : Hitaura : 10 ♂♂, 2 subad. ♂♂, 5 ♀♀, 1 juv. unsexed (May 14-June 6).

The Iora is common in the central dun usually in the borders of forests near villages. During May-June it was generally seen in pairs, but sometimes singly also.

We missed it in the Nepal Valley where Proud (1949, p. 700 ; 1955, p. 60) and Rand & Fleming (1957, p. 143) found it. Ripley (1950 b, p. 383) reported it only from the tarai. Rand & Fleming (loc. cit.) recorded it also in western, west-central and eastern Nepal, at *c.* 275-2000 m. Scully (1879) did not find it in Nepal. It was not included in the earlier list of Hodgson's collection (Gray & Gray, 1846), but in the list of his later collection (Gray, 1863, p. 38) it was entered without any locality.

The juvenile specimen (May 25) has pale yellow downy feathers on underside. One of the subadult males (May 18) has the central rectrices in moult, and the other subadult male (June 6) has only the two central pairs of rectrices black.

The birds were breeding in May-June. Two males taken on May 28 and June 1 had much enlarged testes.

Colours of soft parts : Iris pale yellow ; bill bluish slate, black on culmen and whitish on tip of upper mandible ; legs and feet plumbeous ; claws bluish slate ; pads white.

Measurements :

	10 ♂♂	5 ♀♀
Wing :	62 (2), 63.5, 64 (3), 65, 65 +, 66	60, 61, 63, 64, 65
Tail :	49 (2), 49.5, 50 (3), 50.5, 51, 52 (2)	50 (3), 51, 52
Bill :	—, 17.5, 18, 18.5 (4), 19 (3)	18 (2), 18.5 (3)

Marien (1952) utilized part of the material mentioned above in connexion with his studies on the species.

399. **Chloropsis aurifrons aurifrons** (Temminck). Goldfronted Chloropsis.

Tarai : Simra : 3 ♂♂, 3 ♀♀ (March 4-6). Bhabar : Amlekhganj : 4 ♂♂ (March 7, 8, June 8). Dun : Hitaura, Kusumtar, Paharé Ghat : 4 ♂♂, 1 juv. ♂, 2 ♀♀, 1 juv. ♀ (May 17, 18, 27-June 2, 11).

The Goldfronted Chloropsis is common in the dense forests of lower regions of central Nepal.

Ripley (1950b, p. 384) recorded it also from the eastern tarai. Rand & Fleming (1957, p. 144) found it in the west-central and eastern tarai.

Most of the specimens taken in March have freshly moulted wings and tails, but moult has not started in two male birds (March 4) which are in worn plumage. Two females (March 4, 5) are moulting into adult dress. A male specimen of May 18 has its moult nearly finished, the wing coverts and crown still moulting. Other May-June specimens are more or less worn.

The juvenile male specimen (June 11) looks somewhat like the adult female. Its gold-orange on the forehead and forecrown is dull, it has no trace of golden collar and has very little blue but more of black on the chin and throat.

The juvenile female bird (June 2) has only the anteriormost part of the forehead golden, the remaining part of the forehead and the forecrown have merely a trace of yellow on green. It has no trace of golden collar or any blue patch on the wings or the edges of the wings. Its chin and throat are mixed blue, green and black, and the under tail coverts are with bluish terminal halves. The bill is paler in colour.

Birds taken towards the end of May and early June had almost breeding gonads.

Colours of soft parts : Iris dark brown ; bill black ; legs greenish slate ; feet plumbeous ; claws black ; pads yellowish white.

Measurements :

	11 ♂♂	5 ♀♀
Wing :	93, 95, 96 (3), 96.5, 97 (3), 98, 100	89 (2), 90, 92 (2)
Tail :	65, 68, 69 (2), 70 (4),—, 72, 73	66, 67, 68.5, 69, 70
Bill :	24.5, 25 (5), 25.5 (2), 26 (2), 26.5	24, 25 (3),—

On the basis of the measurements of the material available to me, I do not see any great difference in size between the Cachar and Himalayan birds, so as to warrant the separation of the latter as *Chloropsis aurifrons hodgsoni* Gould, 1861 (type locality Nepal), as suggested by Deignan (1946) (see also Rand & Fleming, 1957, p. 144). My measurements are as follows :

		Wing	Tail	Bill
Nepal :	11 ♂♂ :	93-100 (96.5)[a]	65-73 (69.6) 10 specimens	24.5-26.5 (25.4)
	5 ♀♀ :	89-92 (90.4)	66-70 (68.1)	24-25 (24.8) 4 specimens
North Bengal :	2 ♂♂ :	94, 96	68, 69	25,—
	1 ♀ :	87	—	24
Assam (Darrang, Khasi Hills, Sylhet) :	1 ♂ :	97	71	25
	2 ♀♀ :	91, 95	65, 68	24 (2)
	2 unsexed :	86, 90	62+, 66	—(2)
Assam (Cachar):	1 ♂ :	94	68	—
South Bengal, Bihar (Ranchi, Singhbhum):	7 ♂♂:	95-103 (98.9)	69-77 (72.1) 6 specimens	25-26.5 (26.1) 4 specimens
Orissa, Madhya Pradesh (Mandala, Balaghat) :	1 unsexed :	95 +	70	—

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[a] Mean values are given in parentheses.

400. **Chloropsis hardwickei hardwickei** Jardine & Selby. Orangebellied Chloropsis.

DUN : Hitaura, Bhimphedi : 4 ♂♂, 6 ♀♀, 1 subad. ♀ (March 12, May 4-28). NEPAL VALLEY : Thankot : 1 ♂, 1 ♀ (March 26).

The Orangebellied Chloropsis did not appear to us to be particularly common in central Nepal. We found it in the lighter parts of forests in the dun and the Nepal Valley, occurring in pairs or small parties ; and on one or two occasions noted single specimens.

Proud (1949, pp. 700-701) observed it as very common in the Nepal Valley. Rand & Fleming (1957, pp. 143-144) reported it also from west-central and eastern Nepal at *c.* 915-2285 m.

My March birds are in fresh plumage, and those taken later are more or less worn. A female collected on May 6 has nearly finished its body moult, while another female shot on May 13 has worn tail feathers except the central pair which are moulting. Its body moult is nearly finished.

The subadult female bird (May 22) has brown primaries.

A male specimen taken on May 28 had somewhat swollen testes indicating its nearness to breeding.

Colours of soft parts : Iris dark brown ; bill black ; legs bluish grey ; feet bluish slaty ; claws black ; pads white.

Measurements :

	Wing	Tail	Bill
5 ♂♂ :	94 (2), 95, 98 (2)	73, 75 (2), 79 (2)	25, 25. 5,—, 26 (2)
7 ♀♀ :	88 + , 90 (3), 91, 92 (2)	67, 68 (3),—, 69, 72	24, 24.5 (3),—, 25 (2)

Family LANIIDAE

[**Lanius collurio isabellinus** Hemprich & Ehrenberg. Pale Brown Shrike.

Ripley (in press) states under the range of this bird : ‘ stragglers noted from Nepal ’. I am, however, unable to find any record of this species in Nepal.]

*401. **Lanius vittatus vittatus** Valenciennes. Baybacked Shrike.

The only record of the Baybacked Shrike from Nepal, after Hodgson's collection, has been provided by Rand & Fleming (1957, p. 189) who came across a few specimens in the eastern tarai in January.

402. **Lanius schach tricolor** (Hodgson) Blackheaded Shrike.

BHABAR : Amlekhganj : 1 ♂ (March 6). DUN : Bhimphedi : 1 ♂ (March 11). NEPAL VALLEY : Kathmandu, Thankot, 3.5 km. E. of Thankot on Kathmandu Road : 6 ♂♂, 8 ♀♀, 1 unsexed (March 21-April 10).

The Blackheaded Shrike is a common bird of the Nepal Valley during March-April. In the lower regions of central Nepal, such as the dun and bhabar, it was getting gradually scarcer from March when it began moving towards the breeding grounds. As Ripley (1950b, p. 383) has pointed out, it was found to prefer light forests, scrub jungle and edges of forests in contrast to the Tibetan Shrike's (*L. tephronotus*) preference for more open country.

Polunin (1955, p. 892) found it at *c.* 2745 m. in the Langtang Valley, central Nepal, in summer. Rand & Fleming (1957, p. 190) reported it from western, west-central and central Nepal. Biswas (1960a) recorded it late in May from Khumbu, eastern Nepal, at *c.* 3050 m.

Hybrids between this form and *erythronotus* have been reported from western and west-central Nepal by Ripley (loc. cit.) and Rand & Fleming (op. cit., pp. 189-190). My specimen from Amlekhganj (♂, March 6) is also a hybrid.

One of my male specimens (March 29, Thankot) is highly melanistic, as has already been reported (Biswas, 1950c, p. 452).

Birds were coming to breeding condition towards the end of March and early April, their gonads showing various stages of development.

Colours of soft parts : Iris dark brown ; bill black (sometimes paling to slate posteriorly near the base, and then to white on base) ; legs and feet very dark horny; claws black ; pads white.

Measurements :

	8 ♂♂	8 ♀♀	1 unsexed
Wing :	94, 95 (2), 97 (3), 98, 99[a]	93 (2), 94 (2), 95 (3), 96	96
Tail :	117.5, 118, 120.5, 122, 123, 123[a], 127 (2)	112, 114, 115, 117, 119, 121, 122, 123	—
Bill :	21 (2), 22 (3), 22.5, 23, 23.5	19.5, 20 (2), 21 (3), 21.5, 22.5	22.5

[a] The hybrid specimen.

403. **Lanius tephronotus tephronotus** (Vigors). Eastern Tibetan Shrike.

NEPAL VALLEY : Kathmandu, Thankot : 1 ♂, 1 juv. ♂, 1 ♀ (March 20, 24, April 13).

The Tibetan Shrike did not appear to us to be common in the Nepal Valley during March-April. Single specimens were seen from time to time on tops of trees and other suitable perches in open areas, scrub, about cultivation, etc., especially in the early mornings, until about the end of April.

It was recorded in the Nepal Valley from late September to mid-March by Scully (1879, p. 264), from November to March by Proud (1949, p. 707), and in April by Ripley (1950b, p. 383). In northern central Nepal it was found in summer by Polunin (1955, p. 892) in the Langtang Valley between *c.* 3050 and 4265 m. and by Lowndes (1955, p. 33) in Manangbhot from *c.* 2440 to 3960 m. Ripley (loc. cit.) recorded it also from the eastern tarai in winter. Rand & Fleming (1957, p. 190) reported it from western and west-central Nepal, at *c.* 275-2440 m. in winter. Biswas (1960a) found it in Khumbu, eastern Nepal, at *c.* 4570 m. in April, and preparing to breed at *c.* 3050 m. in late May.

Measurements :

	Wing	Tail	Bill
1 ♂ :	102.5	116	22.5
1 unsexed :	108	124	23.5

I should think Koelz's *lahulensis* (1950, p. 7) is a perfectly distinct subspecies (*contra* Ripley, in press). Regarding the systematic status of the Tibetan Shrike, see Biswas (1961b).

Family CINCLIDAE

404. **Cinclus pallasii tenuirostris** Bonaparte. Brown Dipper.

MARKHU VALLEY : Kulikhani : 1 juv. ♂, 1 ♀, 1 unsexed (April 27).

The Brown Dipper was not frequently encountered by us in central Nepal.

It was reported in central Nepal by Scully (1879, p. 281) from Nawakot district, and the Nepal and Markhu valleys, by Proud (1949, p. 701; 1955, p. 60) from the Nepal Valley, by Ripley (1950b, p. 385) from the Markhu Valley, by Lowndes (1955, p. 31) from Manangbhot at *c.* 3350 m. In west-central Nepal it was recorded by Rand & Fleming (1957, p. 147). In eastern Nepal, Stevens (1925a, p. 364) reported it from the Mai Valley at *c.* 2285 m. in May; Ripley (loc. cit.) found it in the Arun Valley in winter, and Biswas (1960a) in Khumbu up to *c.* 4570 m. between February and May.

The female specimen is in moulting condition.

Measurements :

1 unsexed : Wing 100 + ; tail — ; bill 24.5.

Vaurie (1951a, pp. 15-17) utilized the abovementioned specimens for his studies.

Family TROGLODYTIDAE

*405. **Troglodytes troglodytes nipalensis** Blyth. Nepal Wren.

Troglodytes nipalensis ' Hodgson ' Blyth, 1845, *J. Asiat. Soc. Beng.* **14** : 589. (Nepal, hereby restricted to Sheopuri Range, Nepal Valley.)

We were unable to find this wren in Nepal, and so was Scully (1879). Smythies (1948, p. 440) noted it in autumn up to *c.* 4875 m. in the Gandak-Kosi watershed, central Nepal, where Proud (1952a, p. 363) also found it in spring at *c.* 3050-3505 m. Ripley (1950b, p. 385) reported it only from eastern Nepal at *c.* 2590-3050 m. Polunin (1955, p. 890) found it common in the Langtang Valley, central Nepal, at *c.* 4115-5030 m. in summer. Rand & Fleming (1957, pp. 147-148) recorded it in winter in west-central Nepal at *c.* 2895 m. and in eastern Nepal at *c.* 3050 m.

*406. **Troglodytes troglodytes kinneari** Biswas. Kinnear's Wren.

This wren has not been reported from Nepal by any one except Biswas (1955, p. 87, and 1960a).

In my opinion, both *tibetana* Walton and *kinneari* Biswas are distinct from *nipalensis* Blyth (*contra* Vaurie, 1960, p. 419; Ripley, in press).

Family PRUNELLIDAE

*407. **Prunella collaris nipalensis** Blyth. Eastern Alpine Hedge-Sparrow.

After Hodgson's collection, the Eastern Alpine Hedge-Sparrow was reported from Nepal by Smythies (1948, p. 441) in the Gandak-Kosi watershed, central Nepal, at *c.* 4570 m. in autumn, by Lowndes (1955, p. 32) in Manangbhot, central Nepal, at *c.* 4570-4875 m. in summer, and by Biswas (1960a) in Khumbu, eastern Nepal, at *c.* 3655-5485 m. during March-May.

*408. **Prunella himalayana** (Blyth). Altai Hedge-Sparrow.

After Hodgson's collection (Gray, 1863, p. 36), the Altai Hedge-Sparrow was recorded in Nepal by Proud (1952a, p. 364) in Gandak-Kosi watershed at *c.* 2440-3505 m. in spring, and by Rand & Fleming (1957, p. 182) in the Kali Gandak Valley, west-central Nepal, at *c.* 2810-4265 m. in winter.

*409. **Prunella strophiata strophiata** (Blyth). Rufousbreasted Hedge-Sparrow.

The post-Hodgsonian records of the Rufousbreasted Hedge-Sparrow from Nepal consist of Ripley's (1950b, p. 387) from eastern Nepal at *c.* 1310 m. and 2670 m. in winter; Polunin's (1955, p. 891) from the Langtang Valley, central Nepal, at *c.* 3655-4265 m. in summer; Lowndes's (1955, p. 32) from Manangbhot, central Nepal, at *c.* 3960-4570 m. in summer; Proud's (1955, p. 61) from Sheopuri Range, Nepal Valley, at *c.* 2135 m., and beyond Sheopuri on the north at *c.* 3655 m.; Rand & Fleming's (1957, p. 183) from eastern Nepal at *c.* 3050 m. in winter; and Biswas's (1960a) from Khumbu, eastern Nepal, at *c.* 3655-5335 m. in February-May.

Rand & Fleming's (op. cit., pp. 182-183) birds from west-central Nepal, taken at *c.* 1370-2775 m. in winter and listed under this form and *P. s. jerdoni* (Brooks), are intermediate between these two subspecies according to Ripley (in press).

410. **Prunella rubeculoides rubeculoides** Horsfield & Moore. Robin Hedge-Sparrow.

After Hodgson's collection (Gray, 1863, p. 36), the Robin Hedge-Sparrow was recorded in Nepal by Smythies (1948, p. 441) in the Gandak-Kosi watershed, central Nepal, in autumn (a doubtful observation), by Rand & Fleming (1957, p. 182) from the Kali Gandak Valley, west-central Nepal, in winter as an uncommon bird, and by Biswas (1960a) who found it in small numbers in Khumbu, eastern Nepal, at *c.* 3960-5335 m. in February-May.

*411. **Prunella fulvescens sushkini** Collin & Hartert. Eastern Brown Hedge-Sparrow.

The only record of the occurrence of this hedge-sparrow in Nepal is to be credited to Rand & Fleming (1957, p. 183) who found a single example in the Kali Gandak Valley, west-central Nepal, at *c.* 2805 m. in December.

*412. **Prunella immaculata** (Hodgson). Maroonbacked Hedge-Sparrow.

The only post-Hodgsonian records of the Maroonbacked Hedge-Sparrow from Nepal are Ripley's (1950b, p. 387) from eastern Nepal, at *c.* 2745 m. in winter, and Rand & Fleming's (1957, p. 184), also from eastern Nepal at *c.* 2285 m. in winter.

(To be continued)

On the Marine Fauna of the Gulf of Kutch

PART II—GASTROPODS

BY

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(*With ten plates*)

[*Continued from Vol.* **54** (3) : 706]

INTRODUCTION

The molluscans of the Gulf of Kutch have not yet been studied in a comprehensive manner. Hornell (1916), in one of the pioneering works on the marine zoology of Okha Mandal, described the most common forms. The second attempt to study the marine fauna of the Gulf of Kutch was undertaken by the Department of Zoology, Birla College, Pilani, in 1956 (Gideon *et al.*, 1957). The present account is based mainly on shells collected in three surveys made after that between June 1956 and October 1958. Compared with the Gulf of Kutch the littoral molluscan fauna of the Bombay coast has been better studied (Melvill, 1893, 1894, 1896; Melvill & Abercrombie, 1893; Melvill & Standen, 1906).

The present study is undertaken with the additional aim of studying the distribution of molluscans in the Gulf of Kutch and its comparison with the other well-surveyed Indian coastal regions (Subramaniam *et al.*, 1951; Gravely, 1927, 1942; Satyamurthi, 1952). It is certain that several species are common to all these places but at the same time there are a few which are characteristic of each place. The authors believe that there are still a number of Gastropods in this region which have not been collected. A key to the identification of the Gastropods of the Gulf of Kutch will be published after more material has been studied.

MATERIALS AND METHODS

The material for the present study was collected from Port Okha, Pirotan Island, Byet Dwarka, and Sika. The collections were made mostly from the intertidal zone, both in the morning and in the evening. The low tide allowed two to three hours of collection in the morning and one to two hours in the evening.

Live specimens were narcotised before preservation. The classification followed is that of Thiele (1931) as adopted by Satyamurthi (1952).

DESCRIPTION OF THE AREA SURVEYED

In addition to the regions already described (Gideon *et al.*, 1957) the present survey covers the Beacon area of Pirotan Island and Sika 6 miles off Kanalus:

Beacon area. The Beacon area is mainly sandy interspersed with broken coral rock. At low tide there is three to six inches of water over the rocks, which are covered by a thin layer of mud. This region is marked by the presence of a large number of *Octopus*, *Onchidium*, and *Tetradon*.

Sika. The intertidal zone of Sika is muddy and very vast. The mud is deposited over coral rocks and is waist deep in places. This area is surveyed for the first time.

Family **FISSURELLIDAE**

This family is represented by three genera and five species, as a rule not very abundant. The three genera described here also occur on the east coast of India (Satyamurthi, 1952). Hornell's (1951) revised catalogue of Bombay Mollusca includes four genera of Fissurellidae.

Genus **Diodora** Gray Syn. *Glyphis* Carpenter

The members of this genus are mostly confined to the rocky shores of Okha and Hanuman Dandi. Hornell (1951) observed that they live below low-tide mark and are seldom found except by dredging. This may be true of some species of *Diodora* but in the present survey a large number of living specimens were collected from the rocky shore of Hanuman Dandi. In this area even in the spring tides a large number of rock pools are cut off among the rocks and these specimens were collected from the rocks which surround these rock pools. They are found associated with members of Patellidae, Neritidae, and Turbinidae.

The members of this genus are known as the key-hole limpets because of the presence of an oval or rounded aperture at the apex of the conical shell. The shell is generally provided with radial and trans-spiral ribs. The shape and size vary greatly even within the species.

Diodora bombayana (Sowerby) (Plate 1, Figs. 1 & 2)

Collected from Okha and Hanuman Dandi. It is the only species of this genus collected alive. In their natural environment most of them are covered with algae and it is difficult to distinguish *Diodora* from *Cellana.*

Diodora funiculata (Reeve) (Plate 1, Figs. 3 & 4)

Only empty shells were collected from Okha and Hanuman Dandi.

Diodora ticaonica (Reeve) (Plate 1, Figs. 5 & 6)

Collected from Hanuman Dandi.

Genus **Emarginula** Lamarck

The genus is represented by a single species. The shells are popularly known as slit limpets and can be easily identified from *Diodora* by the presence of a slit on the anterior margin of the shell along the middle line.

Emarginula elongata (Phil.) (Plate 1, Fig. 7)

Collected from Pirotan Island.

Genus **Scutus** Montfort

The genus is represented by a single species. The most characteristic feature is the presence of a marginal notch. The shell is flat and elongated and it does not cover the body of the animal completely. There is no radial sculpture on the outer surface of the shell. There is a line running all around the margin of the shell forming a ring which is incomplete anteriorly.

Scutus unguis (Linn.) (Plate 1, Fig. 8)

Living specimens collected from the Beacon area of Pirotan Island.

Family PATELLIDAE

The family Patellidae is represented only by a single genus and a single species.

Genus **Cellana** H. Adams

The shell is conical and the inner surface of the shell has got a pearly lustre. The shells are popularly known as true limpets and can be easily recognised from the key-hole limpets by the absence of the apical aperture. The surface of the shell in its habitat is covered by greenish algae which match very well with the colour of the environment.

Cellana radiata (Born) (Plate 1, Fig. 9)

They are abundant in Hanuman Dandi, common in Okha.

Family TROCHIDAE

Genus **Trochus**

The shells are conical in shape. The lower part of the body-whorl is angular with flattened base. The outer surface of the shell is sculptured and the umbilicus is usually present. These are commonly found attached to the rocks at low tide.

Trochus stellatus Gmelin (Plate 2, Fig. 10)

Collected from Hanuman Dandi. This species is comparatively rare.

Trochus radiatus Gmelin (Plate 2, Fig. 11)

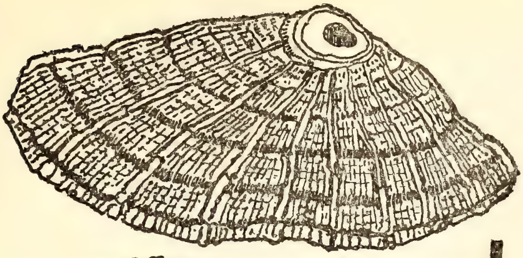
Collected from Hanuman Dandi.

Genus **Monodonta** Lamarck

The shell is trochiform with inflated body-whorl. The surface is provided with minute spiral ribs. The aperture is ovate. There is no umbilicus. The outer lip is thick and ridged throughout while there is a strong tooth in the inner lip. The shell is purple in colour with white spots alternating with brown elongated spots.

Monodonta australis Lamarck (Plate 2, Fig. 12)

Very common in the coral reefs of Hanuman Dandi.



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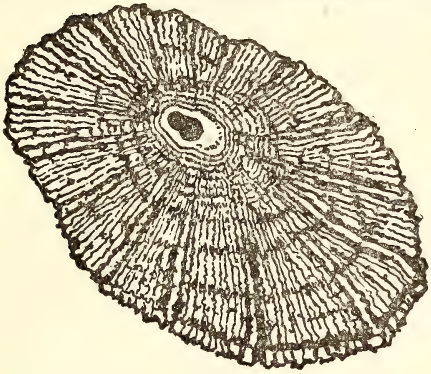

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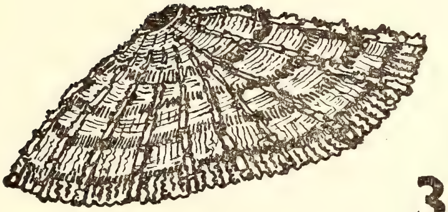

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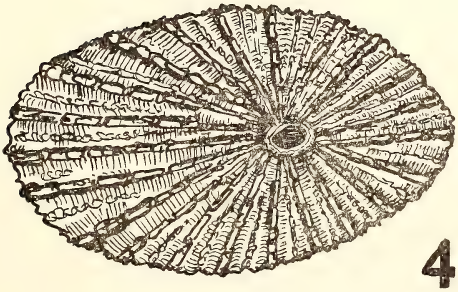

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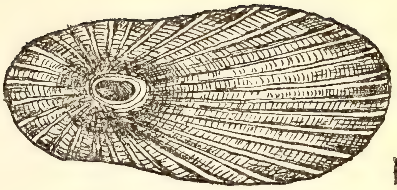

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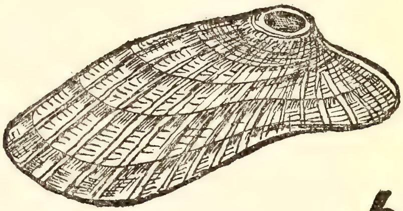

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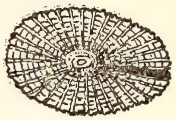

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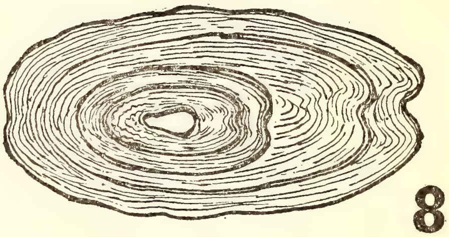

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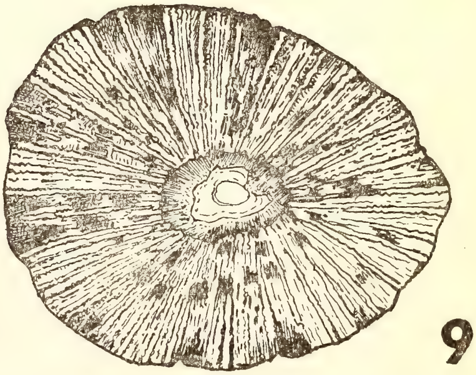

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Fig. 1. *Diodora bombayana*: side view × 1½; Fig. 2. *D. bombayana*: from above × 1½; Fig. 3. *D. funiculata*: side view × 1½; Fig. 4. *D. funiculata*: from above × 1½; Fig. 5. *D. ticaonica*: from above × 1½; Fig. 6. *D. ticaonica*: side view × 1½; Fig. 7. *Emarginula elongata*: from above × 1½; Fig. 8. *Scutus unguis*: from above; Fig. 9. *Cellana radiata*: from above × 1½.

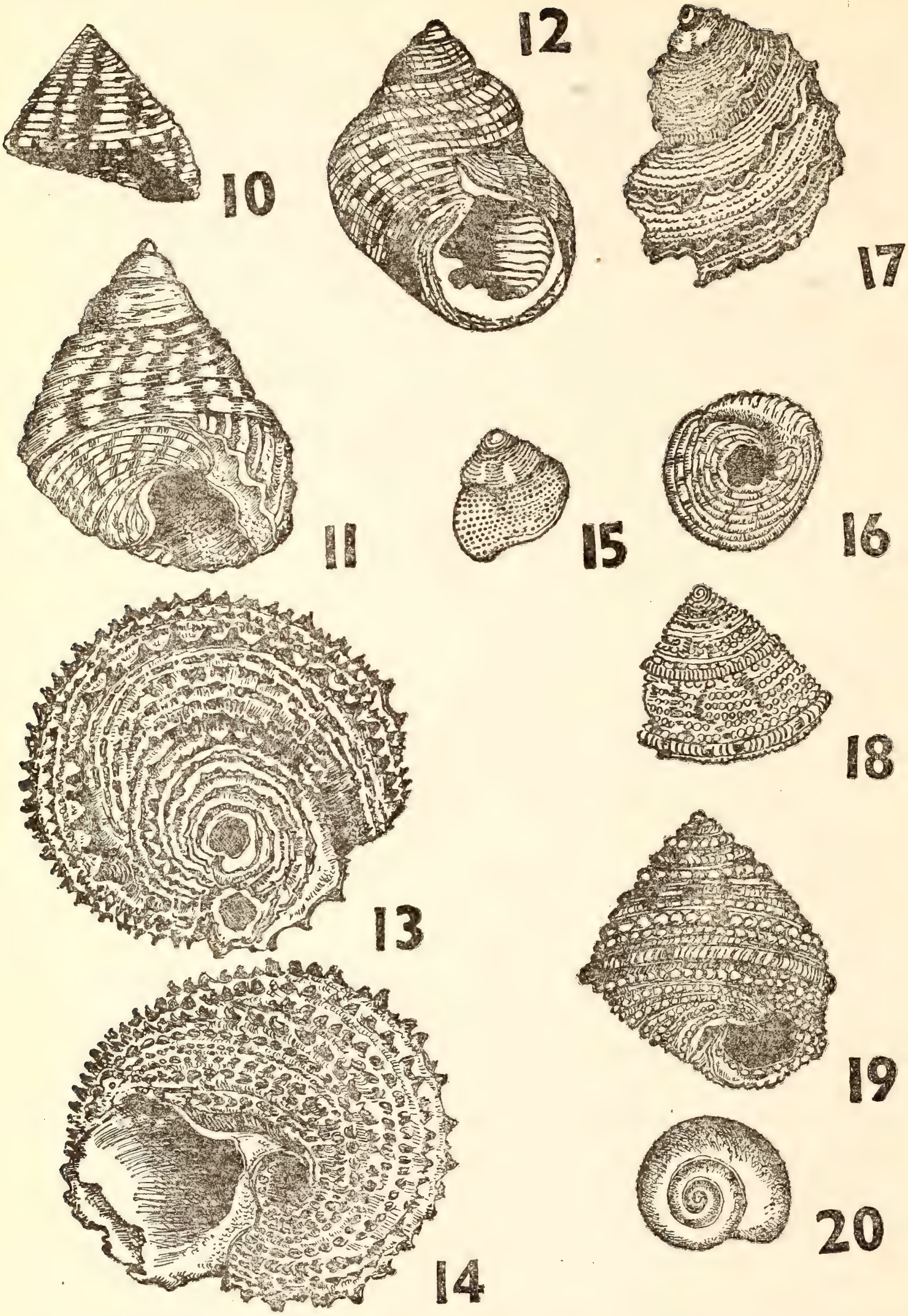

Fig. 10. *Trochus stellatus* : side view ; Fig. 11. *T. radiatus* : showing the base and the aperture ; Fig. 12. *Monodonta australis* : showing the aperture ; Fig. 13. *Angaria plicata* : from above ; Fig. 14. *A. plicata* : from below ; Fig. 15. *Clanculus microdon* : showing the body-whorl ; Fig. 16. *C. microdon* : showing the base ; Fig. 17. *Euchelus asper* : side view ; Fig. 18. *Callistoma* sp. : side view ; Fig. 19. *Callistoma* sp. : showing the base and the aperture ; Fig. 20. *Umbonium vestiarium* : showing the apex.

Genus **Angaria** Röding

It is represented by a single species. The shell is characterised by a low flattened spire. The outer surface of the shell is covered by large spiny processes. The spines are arranged in spiral rows. A large umbilicus is present. The shell is thick, massive and reddish in colour.

Angaria plicata (Kiener) (Plate 2, Figs. 13 & 14)

Living specimens were collected from the low-tide mark of Pirotan Island and were found attached to the smaller broken rocks.

Genus **Clanculus** Montfort

The shell is conical with rounded whorls. The outer surface is smoothly sculptured consisting of beaded spiral ridges. The umbilicus is rounded, large, and toothed inside. The shell is dark reddish-brown with white spots.

Clanculus microdon A. Adams (Plate 2, Figs. 15 & 16)

Collected from Hanuman Dandi.

Genus **Euchelus** Phil.

The genus is represented by a single species. The shell in general shape is rounded with a somewhat inflated body whorl. The suture is deep. The surface of the shell bears granular spiral ridges which are very prominent below the suture. The shell is reddish brown in colour.

Euchelus asper Gmelin (Plate 2, Fig. 17)

Collected from Hanuman Dandi.

Genus **Calliostoma** Swainson

The shell is conical, broader than high, with a pointed apex. The body whorl is angular and spirally sculptured. The beaded spiral ridges are very prominent in the lowermost whorl, while in the upper whorl they are feeble. There is no umbilicus. The shell is whitish.

Calliostoma sp. (Plate 2, Figs. 18 & 19)

Collected from Hanuman Dandi.

Genus **Umbonium** Link

The shells are generally known as button shells. Members of this genus comprise some of the most common and abundant shells on the sandy area of Pirotan Island. This shell is small, brightly coloured, and highly polished. The spire is depressed and the body-whorl is inflated with an angular base. The aperture is somewhat D-shaped. The umbilicus is absent and is filled up by a whitish callus. There is a wide range of colour variation within a species.

Umbonium vestiarium (Linn.) (Plate 2, Fig. 20)

This species was not found in Hanuman Dandi, Balarpur Bay, or Sika. Many shells collected from Pirotan Island were harbouring hermit crabs.

Family TURBINIDAE

The shells of this family are known as turban shells though all of them are not turban-like. *Astrea* looks very similar to top shells. The operculum is stony.

Genus **Turbo** Linn.

The shells are of moderate size with a rounded and inflated body-whorl. The aperture is round and the operculum is hard and stony.

Turbo intercostalis Menke (Plate 3, Fig. 21)

Turbo coronatus Gmelin (Plate 3, Fig. 22)

Next to *Cellana* these are perhaps the most common molluscans in Hanuman Dandi and Okha.

Genus **Astrea** (Bolten) Röding

The shell is top-shaped without an umbilicus. The body-whorls are spinous and the base is flattened. The shell in general appearance resembles a *Trochus*. The colour is pale yellowish brown.

Astrea semicostata (Kiener) (Plate 3, Fig. 23)

Collected from Hanuman Dandi.

Family NERITIDAE

This family is represented in the Gulf of Kutch by a single genus and three species.

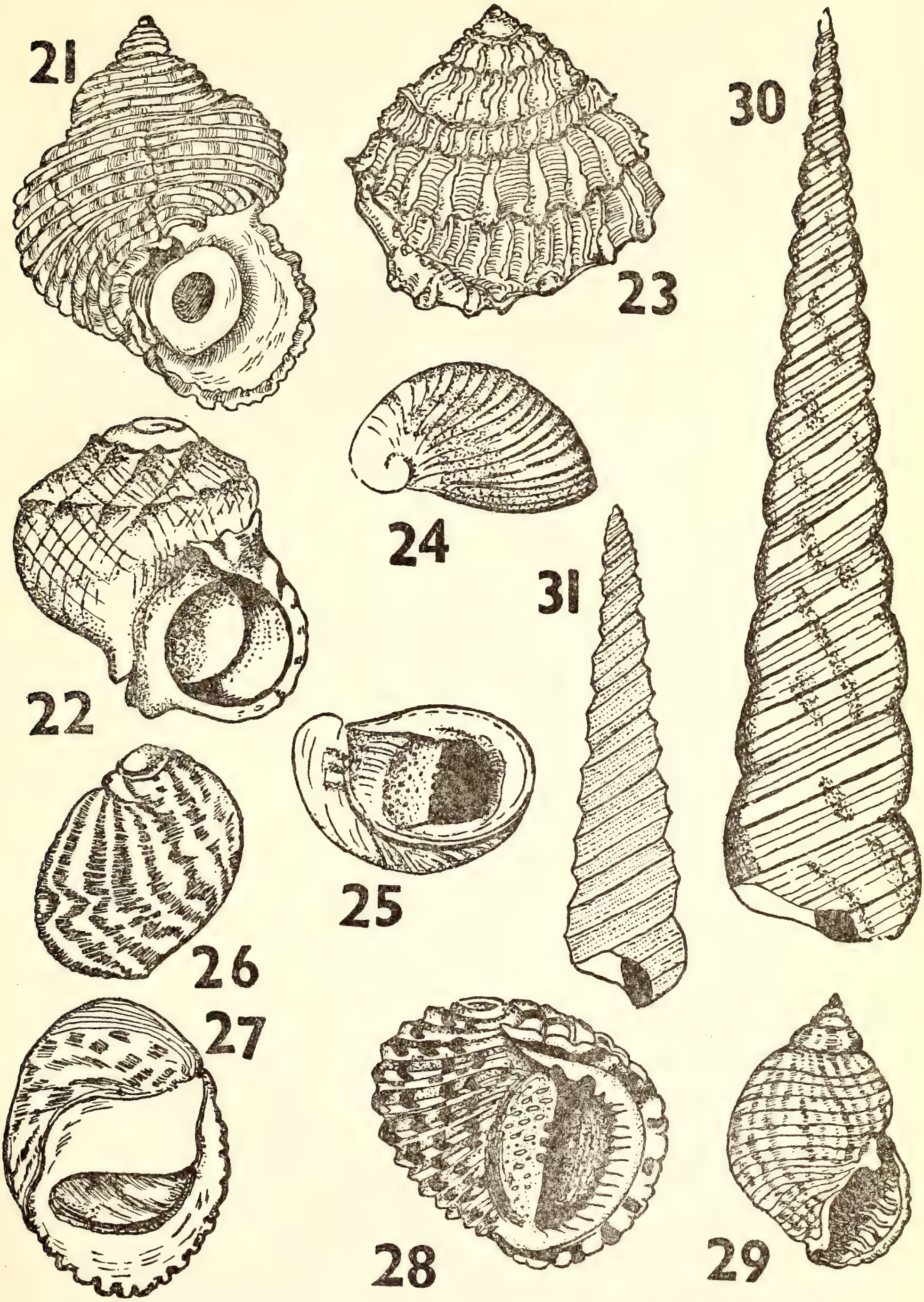

Fig. 21. *Turbo intercostalis* : showing the operculum ; Fig. 22. *T. coronatus* : showing the aperture ; Fig. 23. *Astrea semicostata* : showing the ridges ; Fig. 24. *Nerita albicilla* : side view ; Fig. 25. *N. albicilla* : showing the aperture ; Fig. 26. *N. dombeyi* : showing the body-whorl ; Fig. 27. *N. dombeyi* : showing the aperture ; Fig. 28. *N. plexa* : showing the aperture ; Fig. 29. *Littorina undulata* : aperture side ; Fig. 30. *Turritella acutangula* : Fig. 31. *T. columnaris*.

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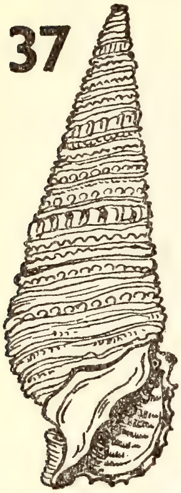

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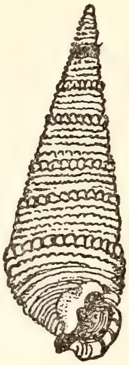

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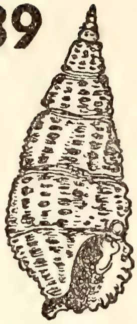

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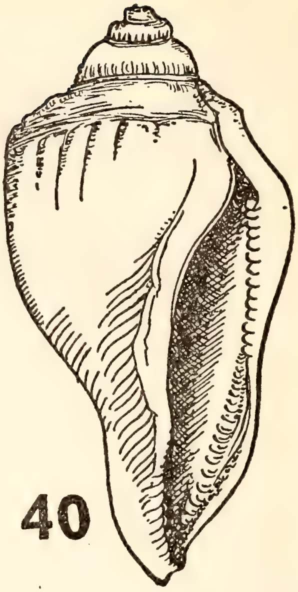

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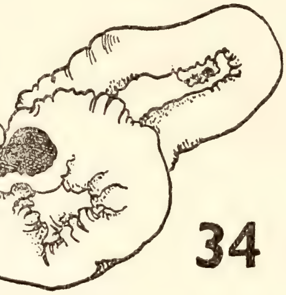

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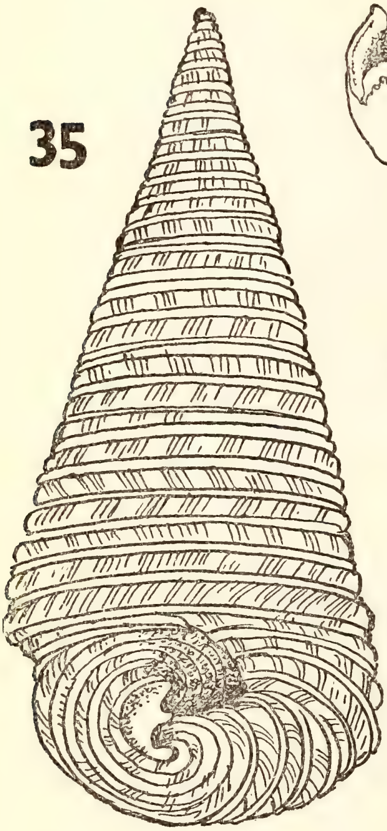

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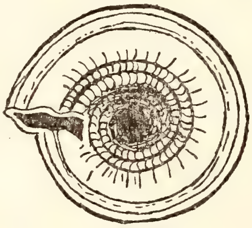

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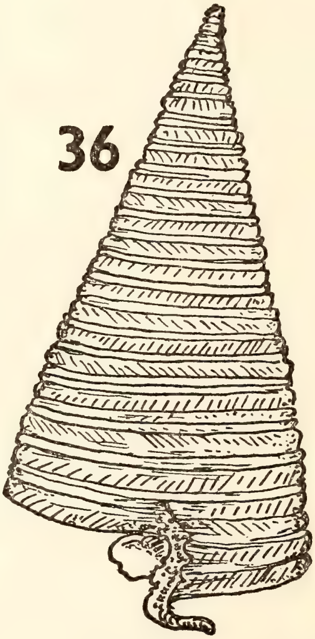

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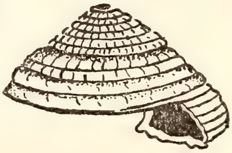

Fig. 32. *Architectonica laevigata* : side view; Fig. 33. *A. laevigata* : from below; Fig. 34. *Vermetes* sp.; Fig. 35. *Telescopium telescopium* : showing the base; Fig. 36. *T. telescopium* : side view; Fig. 37. *Cerithidea fluviatilis* : showing the aperture; Fig. 38. *Cerithium obeliscus* ×1½ : showing the aperture; Fig. 39. *C. scabridum* ×1½ ; Fig. 40. *Strombus urecus* : aperture side.

Genus **Nerita** Linn.

The shells are thick and are characterised by a large body-whorl and a depressed spire. In some cases the spire may be absent. It has got a D-shaped opercular opening. The umbilicus is absent. The size, shape, and colour of the shells are variable. Living specimens of this genus are abundant in Hanuman Dandi and Okha; no specimens have been collected from Pirotan Island or Balarpur Bay.

Nerita albicilla Linn. (Plate 3, Figs. 24 & 25)

Collected from Hanuman Dandi and Okha.

Nerita dombeyi Récluz (Plate 3, Figs. 26 & 27)

Collected from Hanuman Dandi. Very rare.

Nerita plexa Chemnitz (Plate 3, Fig. 28)

Living specimens were collected from Pirotan Island.

Family **LITTORINIDAE**

They are popularly known as periwinkles. According to Hornell (1951) they are found on rocky shores of all parts of the world. The shells are *Turbo*-like in form but differ from it by the absence of the pearly inner lining. The operculum is horny. Only one genus has been found.

Genus **Littorina** Férussac

Littorina undulata Gray (Plate 3, Fig. 29)

Collected from Hanuman Dandi.

Family **TURRITELLIDAE**

Popularly known as 'turret' or screw shells. They are represented by a single genus and are widely distributed in the Gulf of Kutch.

Genus **Turritella** Lamarck

Turritella acutangula (Linn.) (Plate 3, Fig. 30)

Collected from Hanuman Dandi.

Turritella columnaris (Kiener) (Plate 3, Fig. 31)

Collected from Hanuman Dandi.

Family **ARCHITECTONIDAE** (= **SOLARIIDAE**) (Bolten) Röding

Generally known as staircase shells. The umbilicus resembles a winding staircase. Only one genus is recorded.

Genus **Architectonica** (Bolten) Röding

The shell is broad with an angular lower edge and a flattened base.

Architectonica laevigata Lamarck (Plate 4, Figs. 32 & 33)

Collected from Hanuman Dandi.

Family **VERMETIDAE**

They are known as worm shells and are generally confused with the tube of Polychaetes. The shell is irregularly coiled, the aperture is small, and the foot is reduced.

Genus **Vermetes** (Adanson) Daudin

Vermetes sp. (Plate 4, Fig. 34)

Large numbers of living specimens were collected from Pirotan Island and Hanuman Dandi. Fine threads of mucus emerging from the operculum are characteristic of this gastropod. They are found in association with tubicolous Polychaetes.

Family **POTAMIDIDAE**

Popularly known as telescope shells. Two genera are recorded.

Genus **Telescopium** Linn.

The shell is elongated and its whorls are spirally ribbed. It has got a broad flattened angular base. The shell is gradually narrowing towards the apex. The ribs are alternately dark brown and light brown in colour.

Telescopium telescopium Linn. (Plate 4, Figs. 35 & 36)

Collected from Pirotan Island, Hanuman Dandi, and Balarpur Bay.

Genus **Cerithidea** Swainson

The shell is narrow and elongated. The surface is ornamented with small tubercles which are arranged in regular transpiral rows. The aperture is ovate and the outer lip is expanded. The shell is dark grey in colour.

Cerithidea fluviatilis (Potiéz & Michaud) (Plate 4, Fig. 37)

Found everywhere.

Family **CERITHIIDAE**

Popularly known as horn shells. According to Hornell (1951) these gastropods have a tendency to migrate from sea to land.

Genus **Cerithium** Bruguière

The shell is tower-shaped and the apex is drawn into an elongated spire. It resembles somewhat the turret shells but differ from them in having a widely channelled aperture and an everted thickened lip. The surface is ornamented with small tubercles.

Cerithium obeliscus Bruguière (Plate 4, Fig. 38)

Collected from Pirotan Island and Balarpur Bay.

Cerithium scabridum Phil. (Plate 4, Fig. 39)

Collected from Pirotan Island and Balarpur Bay.

Family **CALYPTRAEIDAE**

This family is represented by a single genus. The shells are generally known as crucible shells. It is conical or cap-shaped with an eccentric pointed apex. The interior of the shell is provided with a folded appendage.

Genus **Calyptraea** Lamarck

Calyptraea sp. (Plate 10, Figs. 85 & 86)

Collected from Pirotan Island.

Family **STROMBIDAE**

Popularly known as wing shells.

Genus **Strombus** Linn.

The shell is very thick, smooth with the spire considerably wider and less elevated. The aperture is elongated and narrow and the outer lip is everted into a wing-like expansion. The columella bears a thick callus.

Strombus urecus Linn. (Plate 4, Fig. 40)

Collected from Hanuman Dandi.

Family **NATICIDAE**

The family is represented by two genera.

Genus **Natica** Scopoli

The shell is globular with a depressed spire. It is highly polished. The operculum is horny. The body-whorl is very large. An umbilicus is always present, and the callus is very thick.

Natica tigrina (Röding) (Plate 5, Figs. 41 & 42)

Collected from coral reef off Pirotan Island and Hanuman Dandi.

Natica didyma (Röding) (Plate 5, Figs. 43 & 44)

Collected from Pirotan Island and Hanuman Dandi.

Natica lamarckii Chenu (Plate 5, Fig. 45)

Collected from Pirotan Island and Hanuman Dandi.

Genus **Sinum** (Bolten) Röding

The shell is very easy to identify by its characteristic depressed spire, and its finely striated body-whorl which is inflated and ovoid in shape. The shell is very thin and its inner surface is glossy and iridescent. The spire is visible only in profile. Umbilicus is absent.

Sinum cuvierianum (Récluz) (Plate 5, Figs. 46 & 47)

Collected from Pirotan Island and Hanuman Dandi.

Family **CYPRAEIDAE**

They are popularly known as 'cowries' and are notable for their polished surface and beautiful coloration. The shell is inrolled and the aperture looks like a long narrow slit extending from one end to the other. Both the margins of the aperture are toothed.

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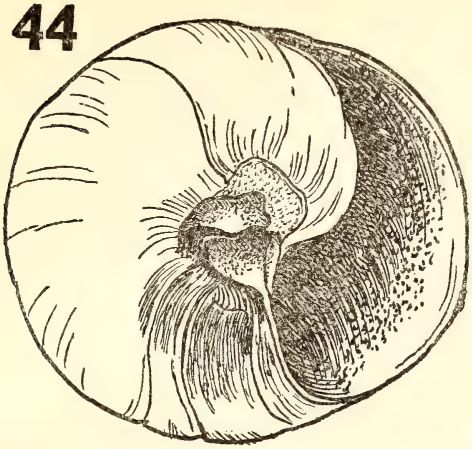

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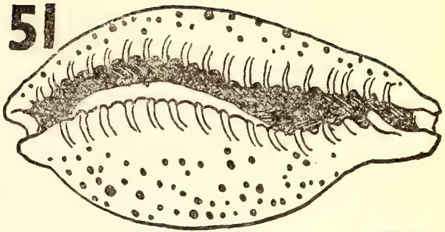

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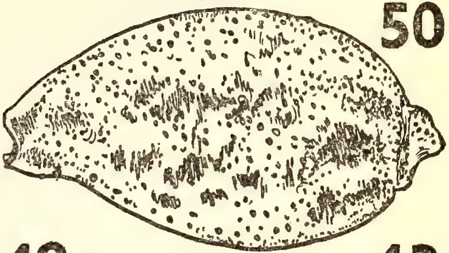

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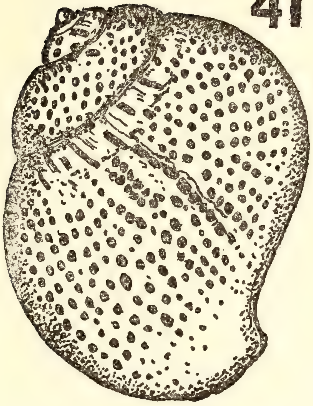

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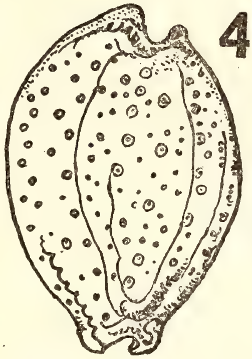

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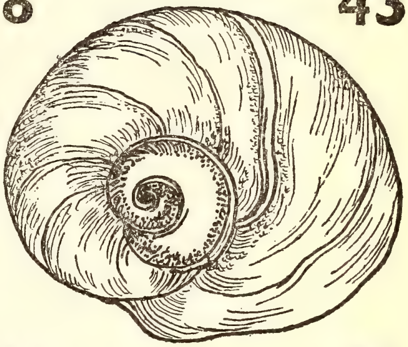

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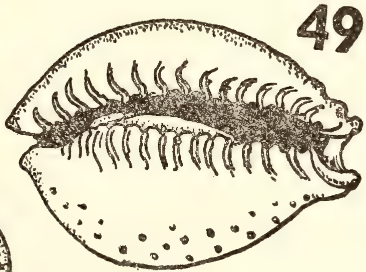

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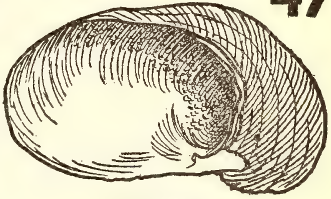

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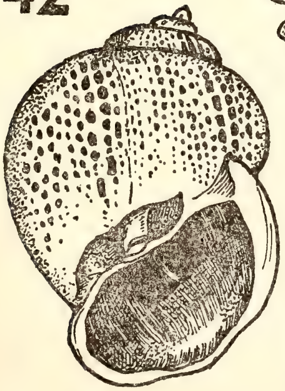

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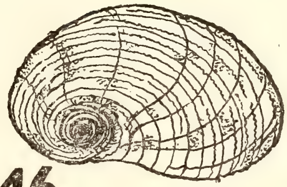

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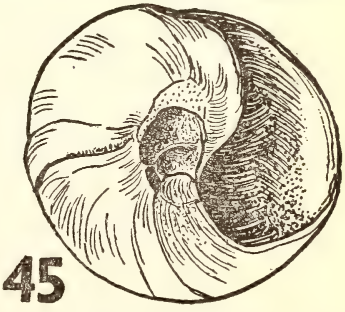

Fig. 41. *Natica tigrina* ; Fig. 42. *N. tigrina* : aperture side ; Fig. 43. *N. didyma* : from the apex ; Fig. 44. *N. didyma* : aperture side ; Fig. 45. *N. lamarcki* : aperture side ; Fig. 46. *Sinum cuvierianum* : showing the body-whorl ; Fig. 47. *S. cuvierianum* : aperture side ; Fig. 48. *Cyparea ocellata* : from above ; Fig. 49. *C. ocellata* : aperture side ; Fig. 50. *C. arabica* : from above ; Fig. 51. *C. arabica* : aperture side.

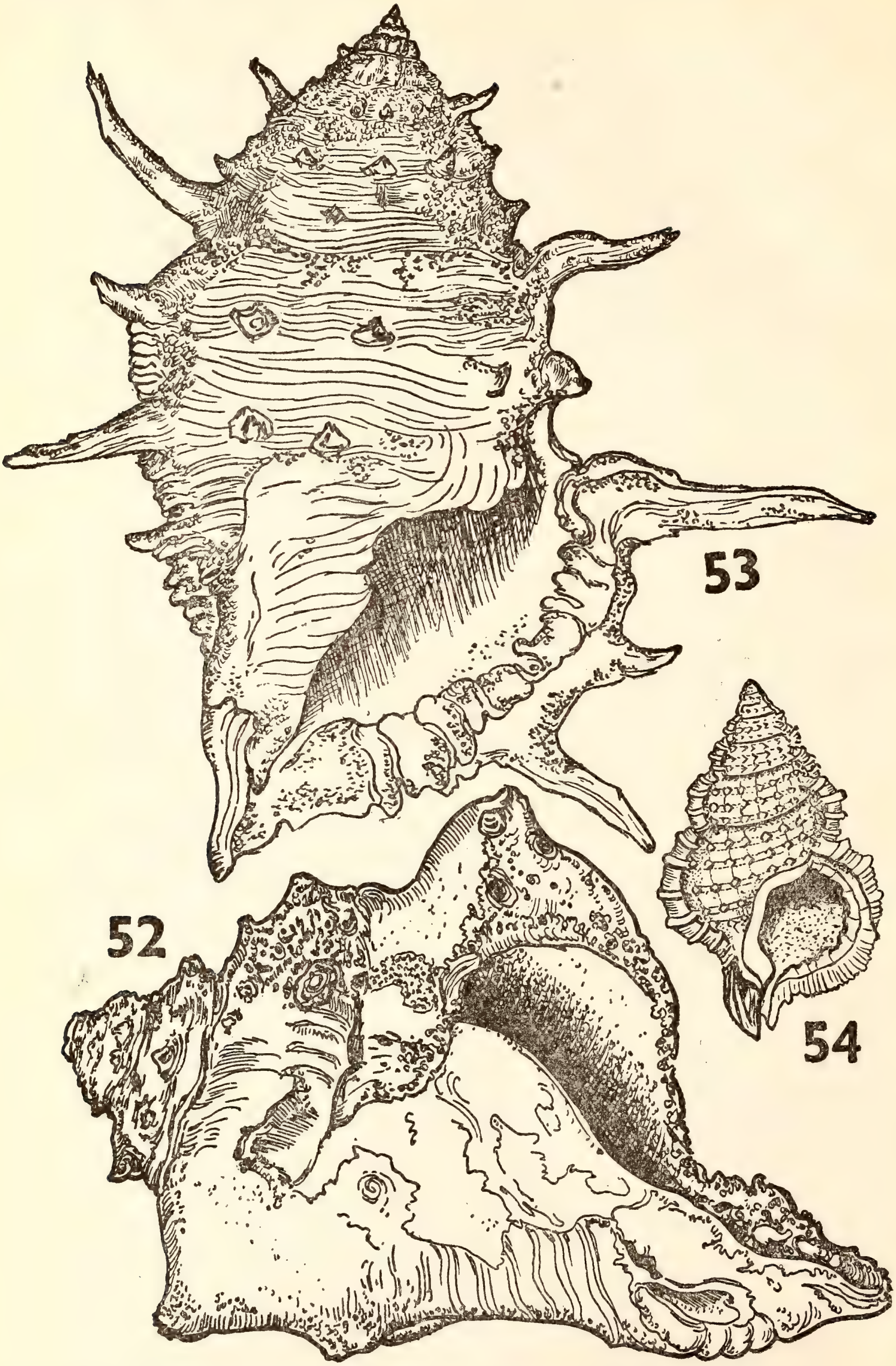

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Fig. 52. *Hemifusus* sp.: aperture side; Fig. 53. *Bursa spinosa*: aperture side × 1½; Fig. 54. *B. granularis*: aperture side.

Genus **Cypraea** Linn.

Cypraea ocellata Linn. (Plate 5, Figs. 48 & 49)

Live specimens were collected from Pirotan Island.

Cypraea arabica Linn. (Plate 5, Figs. 50 & 51)

Collected from Pirotan Island.

Family **VOLEMIDAE**

This family includes shells which are commonly known as knobbed chanks

Genus **Hemifusus** Swainson

The shell is large, thick and solid. The whorls are angularly shouldered with nodule-like swellings in a row. The varices are well developed. The aperture is provided with a long anterior canal. The callus on the columella is thick and strongly wrinkled.

Hemifusus sp. (Plate 6, Fig. 52)

The species could not be identified since the shell was incomplete.

Family **BURSIDAE**

One of the most common families represented in Pirotan Island.

Genus **Bursa** (Bolten) Röding

The shell is strongly sculptured on the outer surface. In some cases spines are present and in some granules. Most characteristic feature is the presence of both the anterior and the posterior canals.

Bursa spinosa (Lamarck) (Plate 6, Fig. 53)

Collected from coral reefs off Pirotas Island.

Bursa granularis (Röding)

Collected from Pirotan Island and Hanuman Dandi.

Family **MURICIDAE**

This family has a world-wide distribution. Tropical species are numerous and include many pretty and peculiar forms ornamented with prominent ridges and spines. The shells are stoutly built, variable in form, sometimes fusiform but more often with a shortened spire and a wide body-whorl. In many species the anterior canal is very long and narrow.

They are widely distributed in the Gulf of Kutch.

Genus **Murex** Linn.

The shell is large with a moderately high spire. The shape is variable, often with varices bearing long spines or stout foliaceous tubercles. The aperture is rounded or ovate; columella mostly with folds; anterior canal long.

Murex trapa Röding (Plate 7, Fig. 55)

Collected from Pirotan Island.

Murex virgineus (Röding) (Plate 7, Fig. 56)

Collected from Pirotan Island.

Murex adustus Lamarck (Plate 7, Fig. 57)

Living specimens collected from Pirotan Island and Hanuman Dandi.

Genus **Thais** (Bolten) Röding

The shells are very variable in shape and size. The spines are generally short and the aperture wide. The sculpture is in the form either of tubercles or of ridges.

Thais rudolphi (Lamarck) (Plate 7, Fig 58)

Collected from Pirotan Island and Hanuman Dandi.

Thais rugosa (Born) (Plate 7, Fig. 59)

Collected from Pirotan Island.

Genus **Drupa** (Bolten) Röding

The shells are small with a low spire. There is distinct sculpture on the surface. The interior of the outer lip is strongly toothed. The anterior canal is short and open.

Drupa tuberculata (Blainville) (Plate 8, Fig. 60)

Collected from Pirotan Island.

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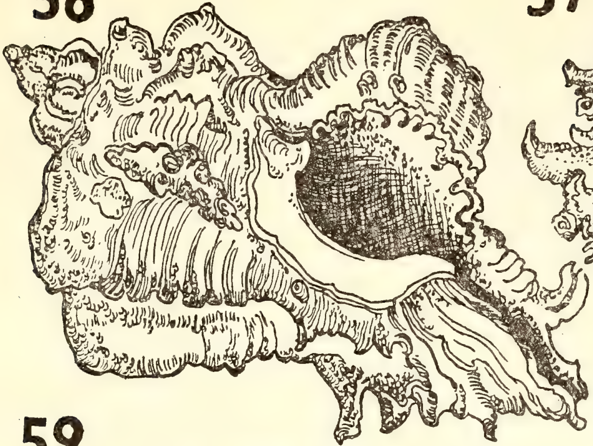

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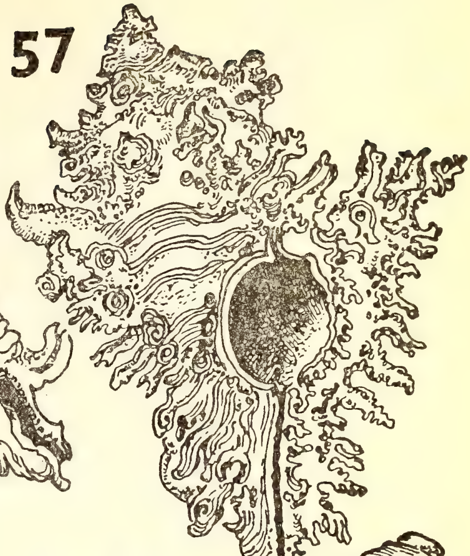

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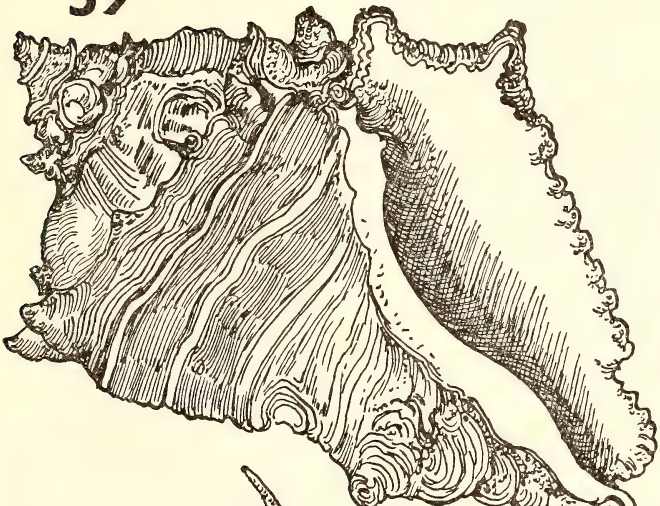

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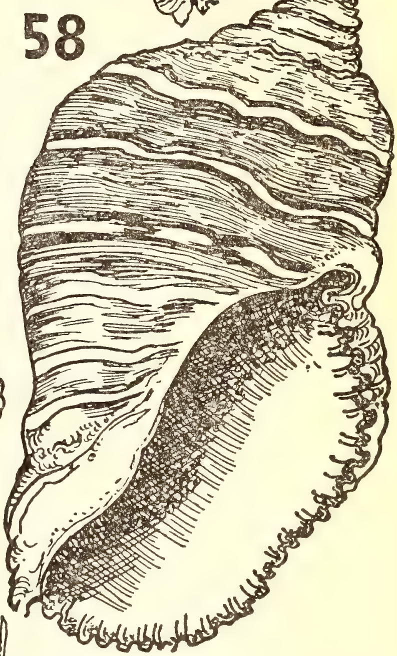

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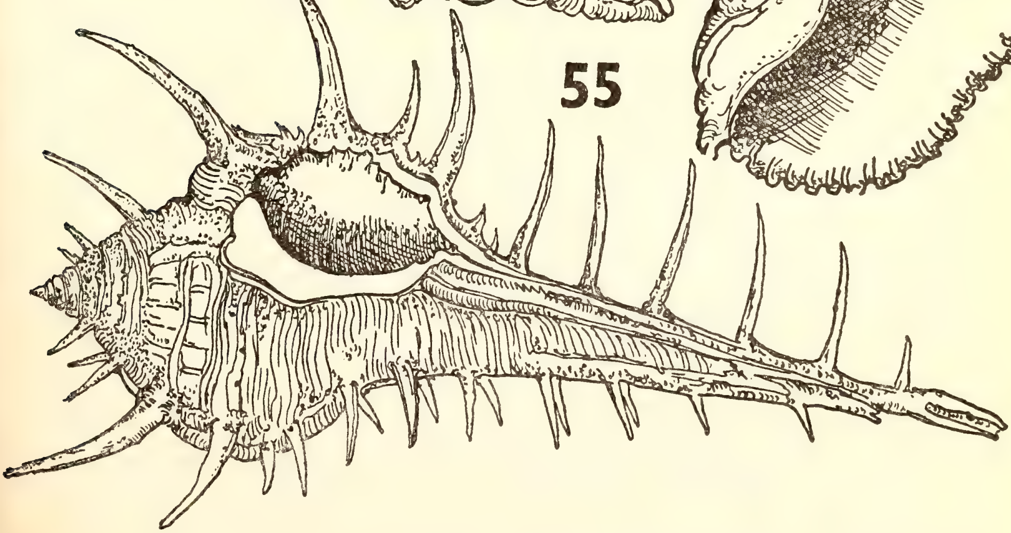

Fig. 55. *Murex trapa*: aperture side; Fig. 56. *M. virgineus*: aperture side; Fig. 57. *M. adustus*: aperture side; Fig. 58. *Thais rudolphi*: aperture side × 1½; Fig. 59. *T. rugosa*: aperture side × 1½.

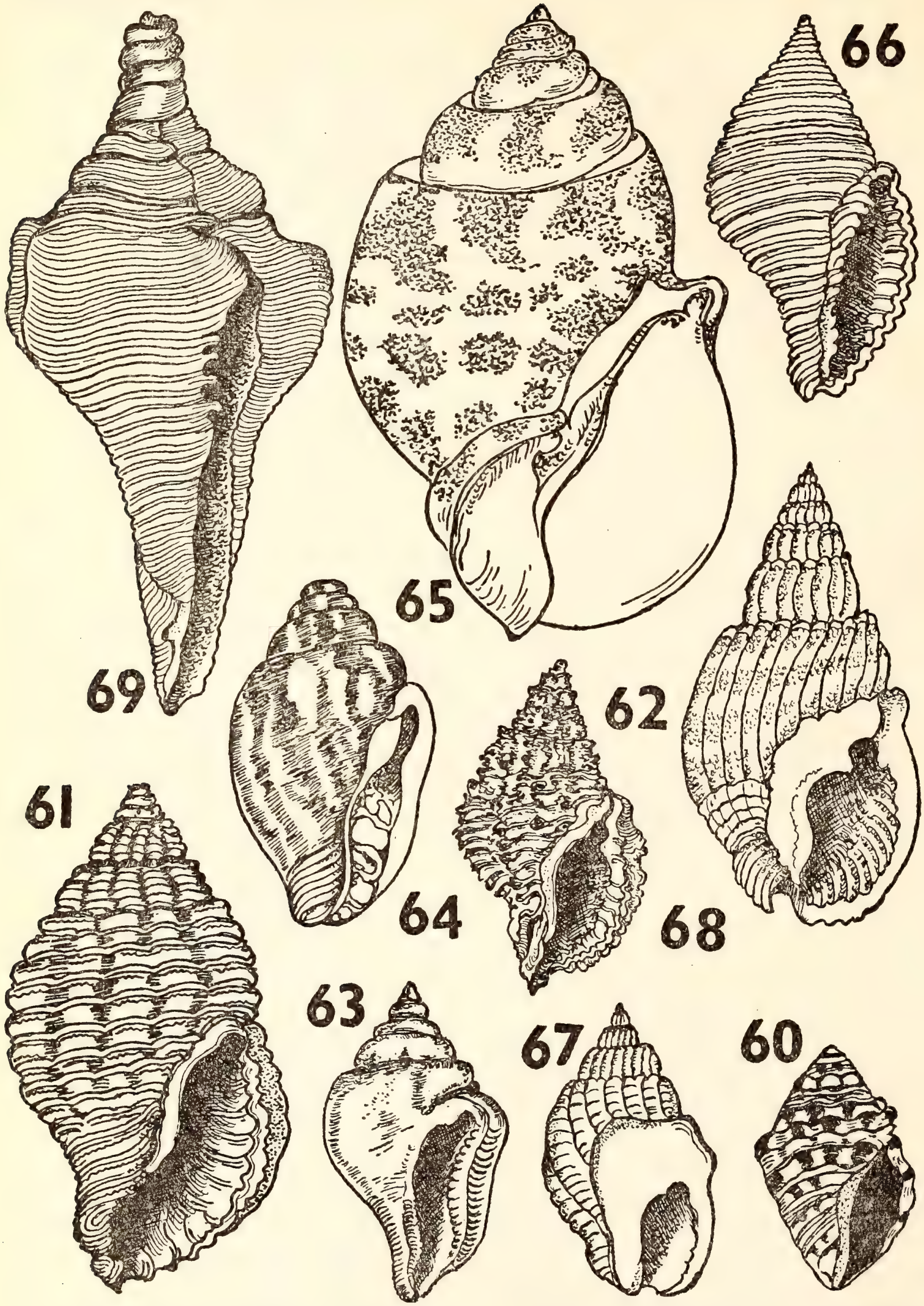

Fig. 60. *Drupa tuberculata* : aperture side × 1½ ; Fig. 61. *D. margariticola* : aperture side × 1½ ; Fig. 62. *D. heptagonalis* : aperture side × 2 ; Fig. 63. *Pyrene versicolor* : aperture side × 3 ; Fig. 64. *P. flavida* : aperture side × 3 ; Fig. 65. *Babylonia spirata* : aperture side × 1½ ; Fig. 66. *Cantharus undosus* : aperture side × 1½ ; Fig. 67. *Nassa thersites* : aperture side × 1½ ; Fig. 68. *N. hepatica* : aperture side × 2 ; Fig. 69. *Fusus* sp. : aperture side × 2½.

Drupa margariticola (Broderip) (Plate 8, Fig. 61)
Collected from Pirotan Island.

Drupa heptagonalis (Reeve) (Plate 8, Fig. 62)
Collected from Pirotan Island.

Family **PYRENIDAE**

The shell is usually small and spindle-shaped. The aperture is narrow and elongated. The surface is smooth or ridged. The outer lip is thick and toothed inside. The anterior canal is open. There is no umbilicus or posterior canal.

Genus **Pyrene** (Bolten) Röding

Pyrene versicolor (Sowerby) (Plate 8, Fig. 63)
Collected from Pirotan Island.

Pyrene flavida (Lamarck) (Plate 8, Fig. 64)
Collected from Pirotan Island and Hanuman Dandi.

Family **BUCCINIDAE**

They are popularly known as whelks.

Genus **Babylonia** Schluter

The shell is more or less oval in shape and its surface is smooth. The colour of the shell is white with brown patches. The spire is not very elongated. The suture is deep and broad. The umbilicus is present in younger animals, in older ones it is completely covered by callus. A very characteristic feature of the genus is a continuous flat winding shelf along the suture.

Babylonia spirata (Linn.) (Plate 8, Fig. 65)
Collected from Byet Dwarka (Balarpur Bay).

Genus **Cantharus** (Bolten) Röding

The shell is somewhat spindle-shaped with close-set spiral ribs. A thick periostracum covers the shell completely. The aperture is oval and the columella is arched. The outer lip is thick and grooved inside.

Cantharus undosus (Linn.) (Plate 8, Fig. 66)

Collected from Pirotan Island.

N.B. When the periostracum remains intact it is greenish brown in colour. It is reddish brown if it is worn out completely.

Family NASSIDAE

This family is represented by a single genus and two species.

Genus **Nassa** (Martini) Lamarck

The shell is without an umbilicus. The spire is pointed and the aperture is oval. The spire is traversed by trans-spiral ribs.

Nassa thersites (Bruguière) (Plate 8, Fig. 67)

Collected from Pirotan Island.

Nassa hepatica (Montagu) (Plate 8, Fig. 68)

Collected from Pirotan Island.

Family FASCIOLARIIDAE

Represented by a single genus.

Genus **Fusus** (Klein) Bruguière

The shell is thin, more or less elongately spindle-shaped with a turretted spire, and is sculptured with minute spiral ridges. There is no umbilicus. The anterior canal is long and slender. The columella bears a thin deposit of callus and is ridged anteriorly. The body-whorl has got prominent shoulders.

Fusus sp. (Plate 8, Fig. 69)

Collected from Hanuman Dandi.

Family OLIVIDAE

This family is represented by two genera and three species. These are generally known as olives and are notable for their highly polished shells. These are burrowing forms.

Genus **Oliva** Bruguière

The shell is roughly cylindrical or barrel-shaped with a short spire. The aperture is elongated and the columellar callus is either smooth or is provided with feeble oblique ridges. A posterior canal is present in the form of a distinct notch.

Oliva gibbosa (Born) (Plate 9, Fig. 70)
Collected from Pirotan Island.

Oliva nebulosa Lamarck (Plate 9, Fig. 71)
Collected from Pirotan Island and Hanuman Dandi.

Oliva lepida Duclos. (Plate 9, Fig. 72)
Collected from Pirotan Island and Hanuman Dandi.

Genus **Ancilla** Lamarck

The shell resembles *Oliva* in many respects. The posterior canal is absent. The most important difference between *Oliva* and *Ancilla* is the presence in the former of a canal running along the suture which is absent in the latter.

Ancilla sp. (Plate 9, Fig. 73)
Collected from Pirotan Island and Hanuman Dandi.

Family **MITRIDAE**

Popularly known as mitre shells and are often very brightly coloured.

Genus **Mitra** Lamarck

The shell is slender and spindle-shaped. There is no distinct anterior canal. The spire is elongated. The shell has a broad whitish band above the suture. They are small, exceeding not more than half inch in length.

Mitra mica Reeve (Plate 9, Fig. 74)
Collected from Pirotan Island.

Family **VASIDAE** (Turbinellidae)

The shells are commonly known as chank or 'sankha'.

Genus **Xancus** (Bolten) Röding

The shell is large, thick and heavy, and is covered with a thick dark brownish periostracum. The body-whorl is large. The anterior canal is elongated and broadly open. The columella bears strong transverse folds.

Xancus pyrum (Linn.) (Plate 9, Fig. 75)

Collected from Pirotan Island and Sika.

Family **CONIDAE**

These are commonly known as cone shells.

Genus **Conus** Linn.

The shell is conical with a very short broad low spire. The aperture is narrow and elongated. The lips are straight and parallel.

Conus punctatus Chemitz (Plate 9, Fig. 76)

Collected from Hanuman Dandi.

Family **TEREBRIDAE**

Generally known as auger shells.

Genus **Duplicaria** Dall.

The shell is tower-shaped with a tall spire bearing numerous whorls which form a narrowly elongated straight-sided cone. The spiral groove dividing each whorl is well marked and it is as deep as the suture. The surface bears flattened trans-spiral ribs.

Duplicaria duplicata (Linn.) (Plate 9, Fig. 77)

Collected from Hanuman Dandi.

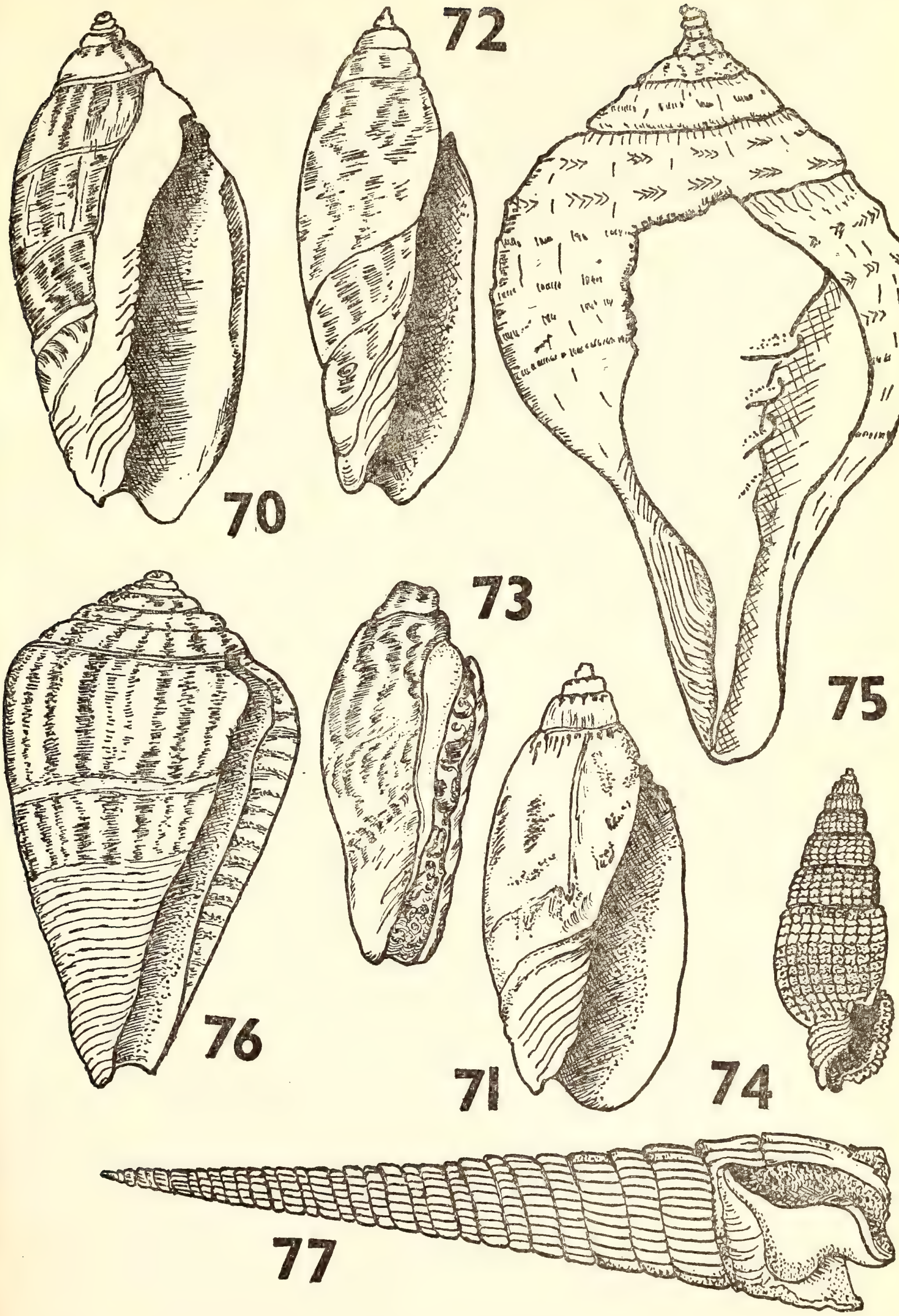

Fig. 70. *Oliva gibbosa* : aperture side ; Fig. 71. *O. nebulosa* : aperture side ; Fig. 72. *O. lepida* : aperture side × 1½ ; Fig. 73. *Ancilla* sp. : aperture side × 1½ ; Fig. 74. *Mitra mica* : aperture side × 4 ; Fig. 75. *Xancus pyrum* : aperture side ; Fig. 76. *Conus punctatus* : aperture side × 3 ; Fig. 77. *Duplicaria duplicata* : aperture side × 1½.

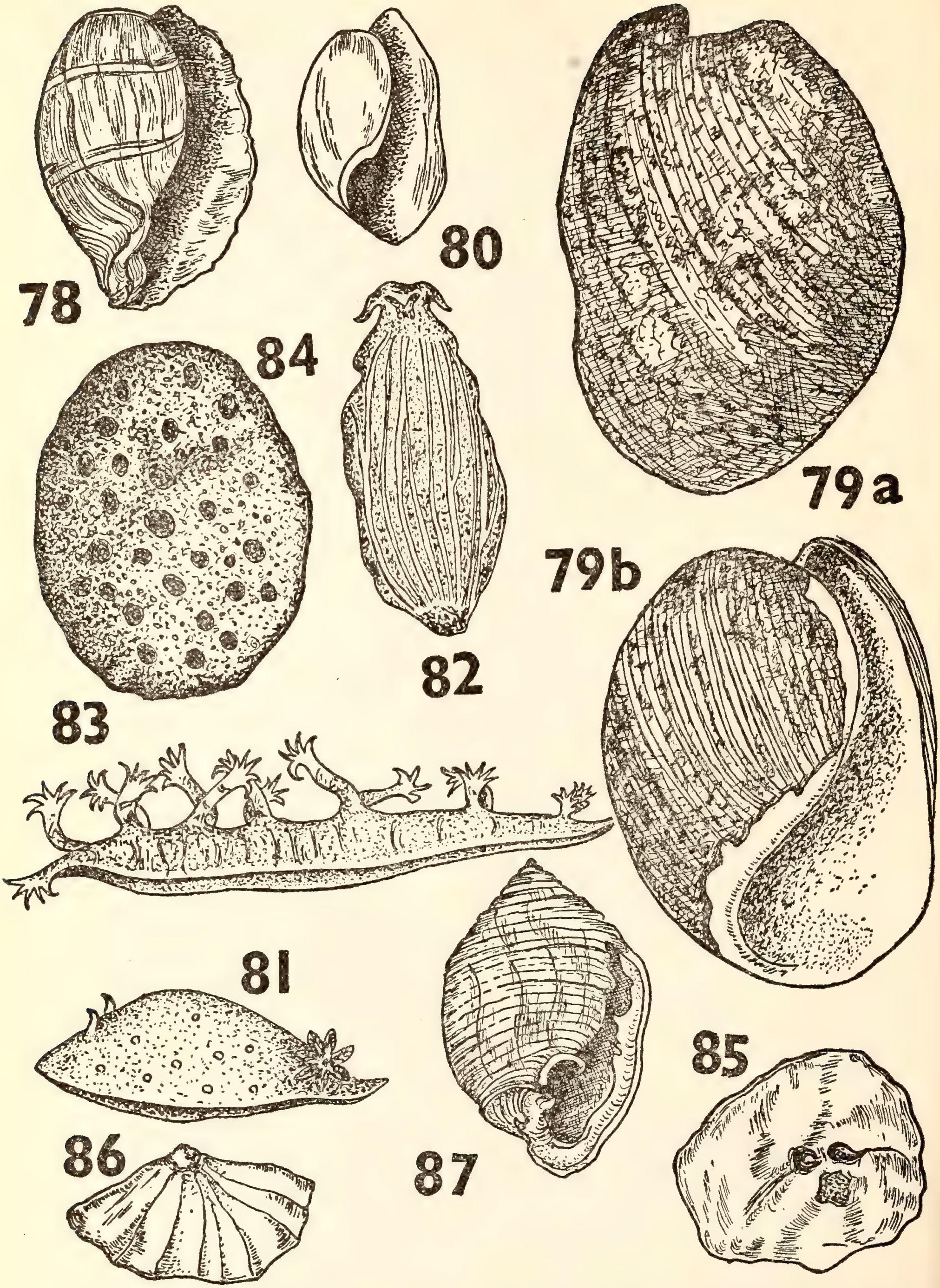

Fig. 78. *Hydatina velum* : aperture side ; Fig. 79a & 79b. *Bulla ampulla* ; Fig. 80. *Haminoea tenera* : aperture side × 1½ ; Fig. 81. *Dendrodoris nigra* × 2 ; Fig. 82. *Pleurophyllidiella* sp. ×7 ; Fig. 83. *Bornella digitata* ×2 ; Fig. 84. *Onchidium verruculatum* ; Fig. 85. *Calyptraea* sp. ×2½ ; Fig. 86. *Calyptraea* sp. : side view ×2½ ; Fig. 87. *Cassidula nucleus* : aperture side.

Family HYDATINIDAE

The shell has the form of bulla and is striped with black and white bands.

Genus **Hydatina** Schumacher

The shell is thin and the body-whorl is oval. The spire is very much reduced and sunk inwards to form a cavity. The shell is yellowish brown in colour with alternating dark and white bands. The foot is very large; no columella and no umbilicus.

Hydatina velum (Gmelin) (Plate 10, Fig. 78)

Collected from muddy region of Balarpur Bay (Byet Dwarka).

Family BULLIDAE

The shells are popularly known as bubble shells and the family is represented by a single genus and a single species.

Genus **Bulla** Linn.

The shell is smooth and the body-whorl is very large. The spire is deeply invaginated into a small cavity to form a crucible-like depression. The columella is covered by a thick polished callus. The shells are brownish in colour.

Bulla ampulla Linn. (Plate 10, Fig. 79 *a* & 79 *b*)

Collected from Hanuman Dandi and Pirotan Island.

Family ATYIDAE

Represented by a single genus.

Genus **Haminoea** Turton

The shell is thin and ovoid, with a wide aperture. It resembles somewhat *Bulla* or *Hydatina*. The colour is greenish white. The shell never completely covers the animal.

Haminoea tenera (Adams) (Plate 10, Fig. 80)

Live specimens are abundant in Pirotan Island and Balarpur Bay. They prefer muddy to sandy areas.

Family **ELLOBIIDAE**

Commonly known as ear shells.

Genus **Cassidula** Férussac

The shell is oblong or ovate. The outer and the inner lips are thickened and expanded. The columella is strongly folded.

Cassidula nucleus Gmelin (Plate 10, Fig. 87)

Collected from Pirotan Island.

Family **DORIDIDAE**

The commonest of Indian Nudibranchs belong to the family Dorididae, distinguished by the presence of a rough tubercu'ated dorsal shield and the possession of external retractile gills.

Genus **Dendrodoris** Ehrenberg

The body is elongately ovate smooth and brightly coloured. The head is small and placed between the overhanging mantle above and the anterior end of the foot below. The gills are nine in number. The colour of the specimen is dark brown. There are numerous black spots on the dorsal side.

Dendrodoris nigra (Stimpson) (Plate 10, Fig. 81)

Collected from Pirotan Island.

Family **ARMINIDAE**

They usually burrow in sand or mud. The family is represented by a single genus.

Genus **Pleurophyllidiella** Eliot

The body is flat. The dorsal side bears a series of well-developed longitudinal ridges. The mouth is ventrally placed. There is no external shell; dorsal papillae absent.

Pleurophyllidiella sp. (Plate 10, Fig. 82)

Collected from Hanuman Dandi and Pirotan Island.

Family **BORNELLIDAE**

The body is more or less elongated and laterally compressed. The rhinophores are large and long-stalked. The lateral margins of the dorsal side bear a series of long-branched branchial processes.

Genus **Bornella** (Gray) Adams & Reeve

Bornella digitata Adams & Reeve (Plate 10, Fig. 83)
Collected from Pirotan Island.

Family **ONCHIDIDAE**

Members of this family are known as sea-slugs. The shell is altogether absent.

Genus **Onchidium** Buchanan

The dorsal surface is convexly arched. The mantle is thick and is provided with numerous tubercles of different sizes. The branchial tubercles are placed towards the posterior margin of the dorsal side. The head bears a pair of eye-bearing tentacles. It is dark green in colour.

Onchidium verruculatum Cuvier (Plate 10, Fig. 84)
Collected from Okha, Pirotan Island, and Sika.

GENERAL REMARKS

In the present study 35 families, 51 genera and 72 species are recorded which include those of the preliminary survey (Gideon *et al.*, 1957). There are still many more shells which are being identified and could not be included in the present report. It can only be predicted at this stage that the Gulf of Kutch is as rich in Gastropod molluscs as any other coasts surveyed.

It is interesting to note that a number of species which are not recorded from Madras or Krusadai (Gravely, 1941; Satyamurthi, 1952) or even from Bombay (Subramanium *et al.*, 1951) are found in abundance in the Gulf of Kutch. *Turbo coronatus* (Turbinidae), *Nerita plexa* (Neritidae), and *Monodonta australis* (Trochidae) are recorded for the first time from the Gulf of Kutch. The authors hope to bring out soon a full record together with a key to the identification of the Gastropods of the Gulf of Kutch.

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Reviews

1. FORESTS OF THE NIGHT. By Jack Denton Scott. Pp. 190 (21.5×14 cm.). 13 illustrations. London, 1960. Robert Hale Limited. Price 18s.

Interest in Jack Denton Scott's FORESTS OF THE NIGHT is aroused right from the blurb when this tells us that for the first time the Indian Government has invited an American hunter to shoot in our jungles. Mr. Scott is an experienced journalist, and in return for his trip he is going to write about shikar so that other Americans, with their much-needed dollars, may be tempted to follow in his footsteps. According to Mr. Scott, the shikar firm to arrange his tour was selected by a Government official and the hunter in charge of the shooting party was reputed to be 'the best professional tiger hunter in the business'.

From the start the story moves fast in a delightfully crisp and smooth style. Many readers will already know Mr. Scott's work, and those who do know it will be aware that he is a great sportsman who, on his own ground, is a very sound man. In the course of the book, Mr. Scott also has some very nice things to say about our country and about Indians.

So far so good, but at this point there crops up a question which needs an answer before going on: Does Mr. Scott's book create a good enough impression to attract foreign sportsmen to our jungles? The answer, regrettably, is an emphatic 'No'. Mr. Scott's tour being sponsored by the Indian Government, the methods described by him will be taken by sportsmen abroad as typical of India and, as such, will brand shikar in India as merciless slaughter, heedless of the safety of the villagers living in the vicinity.

The first shock from this book comes on page 42: 'It would be dark soon, Rao told us and suggested that we use what light was remaining to sight in our rifles. "We hunt for cats by jeep at night. Our plan is to go out this night immediately after dinner."' Then, as if to make quite sure that Mr. Scott has understood him, Rao Naidu says much the same thing again on page 44: '"We hunt the cats and other night prowlers like the wild boar and even the sloth-bear," Rao said. "We use a light and drive the roads. Many of our hunters find it interesting. Have you ever done it?"

' "It's against the law in the States to hunt most animals by night," I said. "Of course we don't have animals that prey on people and that makes all the difference, I guess."

' "You will find that night is the element of the leopard and the tiger," Rao said. "You are meeting him on an uneven basis. He knows the roads, the forests, every ravine around Bori better than any of us. The light, however, almost puts us on an equal footing with him. But not quite. These cats are animals that are always hunting, always on the alert. They may be hunting us before we know that we are hunting them." '

Is this how our Government would have shikar in Indian jungles shown to hunters abroad? True American sportsmen will not come thousands of miles to shoot animals approached in security and comfort by jeep and dazzled by powerful lights. In case our Government doesn't know it, it should perhaps be said here that many Americans will refuse to shoot a driven bird because they regard it as a thoroughly unsporting proposition.

Next, from the bottom of page 47, we are taken out on one of these sneaking, cowardly raids: 'We hadn't ridden with Pathak (the driver) ten minutes before we began to feel secure. This was half the battle, for we would be spending much time in the jeep, hunting at night.

'Everyone was silent now and suddenly Rao switched on a sealed-beam searchlight and began probing the dark forests with it, looking for the burning eyes; every head in the jeep followed the movement like spectators at a tennis match. Every head except that of Pathak. He needed full concentration at the wheel . . . .

'Shortly, without warning, we were at a village. The gaon, a slender man with an amazingly smooth face but faded old eyes and practically no hair, held his arms high and said several Hindi words to Rao. He was vehement and excited.

'Climbing into the back of the jeep, Rao said to me, "He would like us to try to kill the wild boars. Not only do the villagers need the meat badly, but these animals are about as dangerous as anything in the jungle. They charge without provocation."

'While we were driving to the spot where the wild boars were supposed to be, Rao told of what one of the tusked monsters had done a couple of months ago. It seemed that a shikar client had shot at a boar, wounding it.

' "This is our nightmare here in the jungle," Rao said soberly. "It is one reason I try to be very careful of people I take out on shikar.

When an animal like a boar, a bear or any of the cats is wounded, its danger to humans is increased at least fifty per cent. Careless or too quick shooting can wound a tiger or a leopard, and it can prey on these unarmed villagers for months after the hunter has gone back to America. I know you will be sure of your target. The man who shot the wild boar was not. He flashed a shot at it as it headed for heavy cover. He couldn't really see enough of the animal to shoot, and he wasn't a good enough shot to try for the boar while it was running."

'They had trailed it and observed blood, but couldn't find the animal. *So they forgot about it. "There wasn't really much else we could do,"* Rao said (The italics are mine). "I did search for it again, but it had penetrated deeply into the jungle apparently and we never saw it again."

'But one of the village people did. One of the older men from Bori was returning from a neighbouring village about ten miles away where he had been working at a charcoal pit, walking quickly along a yellow dust road, trying to make it to his hut before darkness fell.

' "We never found out exactly what happened," said Rao. "There were long, deep, scuffs in the road where the man had apparently been dragged. From the tracks it was evident that it was a big boar. The man was dead, his stomach had been almost completely ripped out. He never had a chance." '

We are not told the nature and duration of the search that was made for the wounded animal.

Another such incident is described from page 50. The italics again are mine:

'There was silence now and we watched the long beam of Rao's light as it pushed aside the patches of forest-dark. Then, suddenly, dramatically, as these things always happen, the light picked out two big, black animals. They wheeled immediately as the light hit them, charged towards us, then veered, making a sharp, right-angled turn. Sitting on the outside, I tried for them. Rao *attempted* to keep the light on their fleeing bodies. I swung, led the boar in the rear, and squeezed the trigger. *It was a clear shot in the open* and the big .458 boomed like a cannon, but the pigs kept on going and vanished in the thick tangle of ringal, a stunted bamboo growth where even the light couldn't detect them. I started to get out of the jeep.

' "No," said Rao softly. *"It is not safe to get out into the darkness with wild boars around.* They are probably in there now watching and may charge." . . . .

' "Wonder where the third one is?" I asked Rao.

'His face impassive, he said, "It could be a wiser animal, standing back in the thickets and watching us while the other two panicked."

' "Are they that smart?"

' "Smarter," he said. "They are a noble adversary." '

There we have it. The whole sickening sequence ending in the flat, gutless refusal to get out and look for an animal that should never have been fired at in this way and which may or may not have been wounded. No one in that jeep could have been sure beyond doubt that that boar had not been hit. It's all a shocking revelation. One man has already been killed, and now the stage may well be set for another such tragedy. We are not told about a later search, if any, made for the boar that was shot at.

The rest of the book is punctuated with several more shocks of the same kind. There's the incident of the wounded bison: 'There always seemed to be someone waiting with a message, someone to ask us to do something. I was looking forward to some much-needed rest and anything that looked like an interruption was unwelcome. "Another emergency? We might as well belong to a fire-department!"

'Rao smiled. He, too, was tired. But we were his clients and by damn he was going to see that we got our money's worth. "Both bad and good news," he said.

' "Well, give me the bad first, then we can enjoy the good."

' "You know that bison that Mr. Maddox (a client just before Mr. Scott) shot at and I thought he had missed? He has been found."

' "You call that bad news?"

' "Yes, there is only half of him. Apparently Mr. Maddox did hit him and he was dragged down by a tiger. One tiger could never kill the great gaur. He had to be wounded." '

And Mr. Rao Naidu, professional shikari, didn't know! He can let a client shoot at an animal the size of a bison and, unless the animal drops dead, can apparently remain in complete ignorance about the result of the shot! It's all too horribly casual, and his naïve remark that 'I thought he had missed' sounds so like a snatch from some old music-hall ditty that it would be funny if it did not strengthen the impression already gained that, to Mr. Naidu, wounded animals left to die simply do not matter and are just a natural by-product of any of his hunts.

Towards the end of the book another unfortunate leopard (there were two before it) meets the jeep on the road: 'It was close to dawn now with a light that made you think you were under water. Rao stopped the jeep. There on a hummock, crouching at the sight of us, was a leopard . . . It was Mary Lou's (Mr. Scott's wife) turn to bat. She sat, cool as usual, the .308 at her shoulder, stock tight against her cheek. Just before the rifle cracked I saw the cat crouch farther down. Then he was gone on the other side of the knoll, and we were out of the car after him. But he had disappeared. I had stayed with the jeep and Pathak while the other three went searching.

'I was leaning against the jeep talking to Pathak when I saw it. The cat had come back, circling behind us, and there he was about two hundred yards from me, crouching but moving forward, seemingly almost on his stomach. Pathak was petrified. I had the .308 on him fast—too fast. My first shot raised dust spirals beyond him, the other, corrected too hastily, was a little lower but not low enough. Then he was gone. Hearing my shots, Rao came on the run, Mary Lou and Tiwang close behind.

'"Two misses on one cat," Mary Lou said. "That's too much! I can understand yours, the leopard was moving, but mine was almost a set-up shot. I should have had him—."

'"He crouched just as you pressed the trigger," Rao said. "You missed by a bare fraction."'

Perhaps. But it is here suggested that experienced shikaris will see in that last description one clear piece of evidence which shows that the leopard had indeed been hit and deserved to be followed up until the truth, one way or the other, was known. But almost at once the jeep was on the move again, and it had hardly gone five hundred yards when Rao said, '"*Chausingha*! Fourhorned antelope!"

'It was standing about a hundred yards off the road on the edge of a patch of ringals. I got out fast, sighting on it as it broke into a peculiar lope, heading for the trees. At the shot it jumped ahead, turned to the left and fell.'

They certainly got that one, and the shot wasn't actually taken from the front seat of the jeep: just near enough to catch the unsuspecting animal off its guard. Now in Africa, and in America, this kind of shooting would earn the guilty hunter a whopping fine, and the firm responsible for taking him out would stand in peril of losing its licence. Why not the same penalties here?

I have expressed my opinion on the facts as set out by Mr. Scott, and as they will appear to the readers of the book. If the facts are not correctly presented, I would invite the Government of India at an early date to counteract the effect of the book by publishing the true facts, and by expressing its disapproval of the methods of shikar described.

HUGH ALLEN

2. THE OXFORD BOOK OF WILD FLOWERS. By S. Ary and M. Gregory. Illustrations by B. E. Nicholson. Pp. viii+232 (24.5×18 cm.). Oxford University Press, 1960. Price 30*s*.

This is a splendid book, in no way inferior to the already rich collection of volumes illustrating the flora of Britain. To this reviewer this book is a sort of answer to prayer, the sort of dream I have had for many years for the flora of India in general and of Bombay in particular: a book with plenty of illustrations, and good descriptions, and of a price easily within the reach of the average university student.

The present book is meant particularly for the general educated public, especially for such people as find it impossible to wade through the heavy technical books in regional or national floras. But even the experts will find this book interesting. The more common plants of Britain are grouped in the various colour plates by the colour of their flowers; by this grouping even a mere tiro can identify many of the flowers of the field without undue leafing through the book. The right-hand page shows a number, usually 4 to 6, of colour illustrations; on the page facing the plate there is a simple explanation, often with neat line diagrams, of the plants given in the colour illustrations; in addition some other species allied to those pictured in colour are also described in the text. The colour plates all carry an indication of the size of the plants pictured thereon; usually the paintings are life size, occasionally half or one-third life size.

Colour plates and text fill up to page 191; then there follow a few pages of black-and-white illustrations (pp. 193-201); there is next a set of very interesting line drawings (pp. 202-205) giving the general outline and appearance of some of the commoner British trees in winter, when they are leafless, and in summer with their full foliage.

At the end of the book there are notes on naming and classifying plants, on ecology, and on other matters, meant to help the more botanically inclined reader. The book closes with an index of all scientific and vernacular names mentioned in the text.

This reviewer has gone through the book in detail, and finds nothing but praise for the splendid and artistic illustrations and the concise but very careful descriptions. To put it briefly: I find this book a challenge to Indian botanists and artists. Our school children would certainly feel more attracted to the study of nature in all its aspects if we could provide them with books such as the present under review at a moderate price.

The printing both of the text and of the illustrations and the general presentation of the book is in keeping with the very high standards of Oxford University Press.

H. SANTAPAU

3. YOUR FACE FROM FISH TO MAN. By M. S. Mani. Pp. 85+ii (19.25×12.5 cm.). With line drawings. Bangalore, 1960. The P.T.I. Book Depot. Price Rs. 3.

This is the first of a series of popular books on biology. The author gives a short account of vertebrate evolution, taking as his central theme the evolution of the human face from the ancestral fish-head. He discusses among other things the changes in the muscular system which gave rise to the upright posture. This meant that the head, instead of weighing down one end of the spinal column, was balanced on top of it. It was therefore freed for growth. The bones of the ancestral cranium bulged outwards to accommodate the larger brain, and the bones of the face changed in size and proportion with them. The facial muscles shifted their attachments and some of them grew until they became capable of giving rise to the complex expressions characteristic of the human face today. A final chapter sums up the possible future of the race—not a very bright one from the aesthetic point of view. If present trends continue, the dominant species of the future will have a hairless, toothless brain-case, to which a diminished trunk and limbs will be attached as an appendage!

The illustrations are a valuable aid to the understanding of the text.

One hopes that this series will succeed in introducing biology to a wider public.

A.B.

4. TIGER TRAILS IN ASSAM. By Patrick Hanley. Pp. 174 (22.20 × 14 cm.). With 15 photographs and 1 map. London, 1961. Robert Hale Ltd. 18*s*.

A new book on India's wild life is all too rare an event and is therefore doubly welcome to the naturalist and the lover of wild things, more particularly if its main content comprises personal observations on the habits and ways of life of the animals, as opposed to a recital of shooting trips. Mr. Hanley's book has an added interest in that it is almost exclusively about the wild life of Assam, a subject on which the few books which have appeared in recent years have had little to say.

The thesis of the book is very agreeable—'there is far greater thrill to be had out of watching and learning about the habits and behaviour of wild animals in the jungle, than one can ever experience when shooting them. And if danger and excitement is wanted, there is far more of these to be found in one journey into the jungle on foot, unarmed, than can ever be had by hunting tigers, leopards, or other wild animals from the back of an elephant, or from a safe seat in a machan on a tree, or even by gunning for them on foot.'

I read with the greatest sympathy of the loss of the author's entire collection of photographs in the war, for they were taken, Mr. Hanley tells us, 'at great risk' and 'recorded jungle incidents of the rarer kind of animal behaviour which only falls to the lot of man to witness perhaps once in a lifetime'. Some of these must have been unique, as few men have had the uncommon good luck even to have seen such jungle incidents, let alone photograph them.

Mr. Hanley makes no claim that what he has written is to be taken as authoritative on animal behaviour, and says he merely records what he saw at different times. This is disarming, but some of his experiences and observations related in the book are most unusual.

He must have been singularly fortunate to have seen tigers kill their prey on more than one hundred and twenty separate occasions (I have seen it only once!), and have exercised an equally singular attraction for tigers to have had sixty odd encounters with them at distances from six to twenty feet. He must, too, have seen more giant encounters between the great animals of the jungle than any other man, living or dead—tiger against tiger (more than once), fighting for a mate; tiger against wild boar; sambar against wild dogs; leopard against python; leopard against tiger; and so on. His record, besides, of ducking out of a charging leopard's way twice must be unique.

The account of Bengala, the great tiger, makes fascinating reading. I was not however greatly convinced of this tiger's wisdom, about which much is said when he is introduced to the reader. He was said to have evaded every hunter for ten years despite their determined efforts to shoot him. Yet the same tiger gave so many separate opportunities to Mr. Hanley to summarily get him. Or perhaps he was that bit extra clever to know that Mr. Hanley was harmless. Four times the author saw him in the moonlight standing still at a distance of only a few feet. Mr. Hanley admits that if he had had a gun with him, he could not have missed him. Then there was the occasion when Bengala killed a buffalo to the rear of his bungalow and made a sitting target while he settled down to a long and leisurely meal.

The estimate of Bengala's weight of 650 lb. cannot be accepted. A tiger ten feet six inches long (estimated) *over curves* cannot possibly weigh this much. Compare Brig.-Gen. Burton's estimate of the weight of the great Ambari tiger which he shot and examined—550 lb. for a length of nine feet eight inches *nose to tip*. Bengala's photograph shows a splendid, muscular tiger, without an ounce of surplus fat on him. A great tiger immediately after a big feed might conceivably weigh considerably more than normal, but a weight of 650 lb. would be more appropriate to Baikov's Manchurian tigers. There are a couple of these in the Alipore Zoo in Calcutta, and, judging from size, might tip the scale well in excess of 600 lb. in their natural habitat, the *Taiga*.

References to tigers and leopards hunting by scent contradict the known facts about these animals. Even so great an authority as Dunbar Brander showed conclusively that the sense of scent of the tiger was extremely poor, and the great carnivores depended entirely on sight and hearing both to hunt and for most other purposes. Mr. Hanley makes the astounding statement that 'the sense of smell of a tiger is more acute than any other animal in the jungle . . .' I should think, on the other hand, that every other major animal in our jungles has a far better sense of smell than the tiger.

Certain inaccuracies in the book could have been avoided by so experienced an observer of wild life as the author. He divides the leopard into three different types—the leopard, the cheetah, and the panther. He admits that the panther is a leopard posing under a silly alias. But he goes on to say that the panther is slightly larger than the leopard. The fact is, of course, the leopard and the panther are two names for the same animal—despite what some old-time hunters and a few others have said. The two names have been given based almost entirely on variation in size, and sometimes a small variation in colour. The size differences are associated with differences in skull conformation and it is known that the animal develops the occipital ridge with age. Its absence in a younger animal does not make it another variety. The cheetah is no kind of a leopard. The name by which it used to be popularly known—hunting leopard—was attractive, but a misnomer just the same.

Again, Mr. Hanley says that Assam hoolocks are called langurs in other parts of India. This is of course incorrect. The hoolock is a gibbon and an ape, and does not occur west of Assam. The langur is a monkey with a very wide distribution. An incredible observation is that while sitting up in a *machan* overlooking a water-hole, numbers of lynx and civet cats came down to drink.

Nevertheless, Mr. Hanley's accounts of jungle life are full of interest, and his great humanity towards its inhabitants made a deep impression on me.

B. SESHADRI

Miscellaneous Notes

1. GOLDEN LANGURS *PRESBYTIS GEEI* GEE (KHAJURIA, 1956) IN CAPTIVITY

During early December 1955, a friend and I visited the Sankosh River on a fishing holiday. On arrival at the Jamduar Forest Bungalow, we found a scientific party there, who were collecting specimens of the Golden Langur, *Presbytis geei* Gee (Khajuria, 1956), for the Calcutta Museum. We helped the collectors obtain some specimens during the course of which I acquired two baby Golden Langurs, male and female, for myself. These I estimated to be 2-3 months old at the time of capture.

They did not show any signs of being afraid of humans, and took quite readily to a bottle of diluted condensed milk, and also ate oranges and bananas.

I took these young langurs back to the garden in the Terai (Darjeeling District). There they were kept tied up on the lawn or verandah during the day, and were put away in a box, well padded with old blankets for the cold nights.

After a month or so they became very tame and would come eagerly when they saw one approaching with food, and so I was able to let them play around in the compound, where they generally stayed in the bauhinia trees, and we could always catch them again by enticing them with food.

At the end of about 3 months the male died, without having shown any indication of ill health. The female thereupon became very lonely, and showed her unhappiness by making the wailing, almost a whistling, noise that seems to be peculiar to the Golden Langur.

It so happened at this time that the female of a pair of tame hoolocks of mine died. For a number of years these monkeys lived a perfectly free and normal life in the jungle behind my bungalow, which was at an elevation of approximately 1800 feet (550 m.). They wandered over vast areas of jungle, but always came back to the bungalow to take food, particularly when natural foods in the jungle were scarce. After the death of the female the male hoolock became lonely and dejected and seldom ventured far from the bungalow. When his mate was alive they took little notice of the young langurs, although they often fed together, but now the female langur appeared to be attracted to the hoolock, and though he was rather shy of her approach to begin with, invariably taking to the roof of the bungalow where the langur was unable to follow, he gradually overcame his timidity. It happened that one very cold, wet morning he actually allowed the langur to snuggle up to him while he was sheltering under the front porch. They spent the rest of the night sheltering there and from that day on they were firm friends. The hoolock used to go off occasionally into the jungle, and at such times the langur would sit on the roof and wail as she could not follow, being too young to face the hazards of the jungle. The male for his part never stayed away long, coming back almost every day, but spending the nights in his own haunts among the trees.

As the langur grew stronger she followed more and more after the hoolock. He would often be well ahead, but would come back on hearing her wail and help her along, and in this manner soon built up her confidence to move through the jungle on her own. Now they would go off long periods at a time and, although to begin with the langur always came back to the bungalow to pass the night on the beams of the porch, she eventually adopted the habit of the hoolock and took to spending the nights in the trees. They always called at the bungalow first thing in the morning and were given a meal of bread and milk and fruit, and then either sat on the bungalow roof or went for a short jaunt in the jungle. They would return in the early afternoon for a second meal, after which they played among the bauhinia trees in the compound, and as evening approached they made off into the jungle to their sleeping places (which, by the way, I never discovered).

When natural foods were plentiful they often missed out their visits to the bungalow for a day or two at a time.

This state of affairs continued until mid 1957, by which time the langur was fully grown. The visits became very infrequent at this time as far as the langur was concerned, but the hoolock continued to come on his own, and ultimately the langur stopped coming altogether. I rather think she must have paired up with a Common Langur, as I had often noticed a troupe in the same area of jungle where my monkeys used to live, particularly an old solitary male who was often observed quite near the bungalow.

The following are points of interest observed during the period I had the langurs:

FEEDING. When first captured they were fed from a bottle containing very diluted condensed milk which was later replaced by diluted cow's milk. They became very used to the bottle and frequently quarrelled over its possession. Oranges were eaten readily from the outset, and later bananas, bread-and-milk, rice-and-milk, and any fruits that were available, e.g. mango, papaya, litchis, etc. From the age of about 5 months onwards, they started to catch and eat insects such as spiders, grubs, and caterpillars, and had a special liking for grasshoppers, which were caught for them. This habit continued into the adult stage, as I often saw the female hunting insects immediately after having eaten her meal from the bungalow. She appeared to be fond of any brightly coloured flowers, with the result that the buds of orchids, bauhinia, roses, etc. were pulled to pieces, and the tastier petals eaten with relish. I also noticed her eating tender green leaves, but unfortunately do not know the names of the trees from which they were taken. Amongst wild fruit the yellow ficus or peepul was eaten as well as others, but here again I cannot give the names.

COLORATION. When first obtained they were a light golden yellow which gradually darkened to a rusty gold with maturity, the male appearing to be a shade darker than the female. No change of colour was remarked with the different seasons, but this may have escaped my notice.

HABITS. Appeared to be extremely gentle by nature. Gregarious, as at any time one was left it would wail continually until reunited with its companion. Curiosity not so marked as with other species of monkey, but intelligence I would rate quite high. Did not show any affection towards human beings, but very much so amongst themselves, and of course later with the hoolock. Extremely clean in all their habits: no distinctive body smell as is evident with other monkeys.

They had the usual monkey's fascination for a mirror. The female used to spend hours together snuggling up to her own reflection in the window panes of the bungalow. Very playful in the company of the hoolock.

SOLGAI T. E. & P. O.,
CACHAR,
ASSAM,
May 25, 1961.

P. L. ACHARD

2. RECOVERY OF A RINGED TIGER!

Last March I had some guests at my farm near Kichha (Kumaon terai) for a shoot. One of the tigers shot was found to have a collar of twisted iron wire round its neck (two rounds of wire with a loop in which the loose end of the wire was secured). The tiger, a male measuring 8 ft. 7 in. between pegs, was in good condition and quite wild. When followed up after being wounded, it charged our elephants viciously and put them to flight before being shot. The collar was quite loose indicating that the animal was not very young when it escaped from captivity. The tiger had perhaps escaped from a circus, but curiously we did not hear of any such escape, or of any circus camping within 20 miles of the farm in the last year or so. My brother mentioned that he had read in the Lucknow *Pioneer* of a tiger escaping from a circus camping at Mainpuri a few months back. A letter to the editor of the newspaper has remained unreplied. Mainpuri is about 180 miles (290 km.) from Kichha in a straight line. Do you think that the Mainpuri tiger could be the one shot on the farm? The distance and the wildness of the tiger are perhaps against the assumption.

464, BEHARIPUR,
BAREILLY, U.P.,
July 26, 1960.

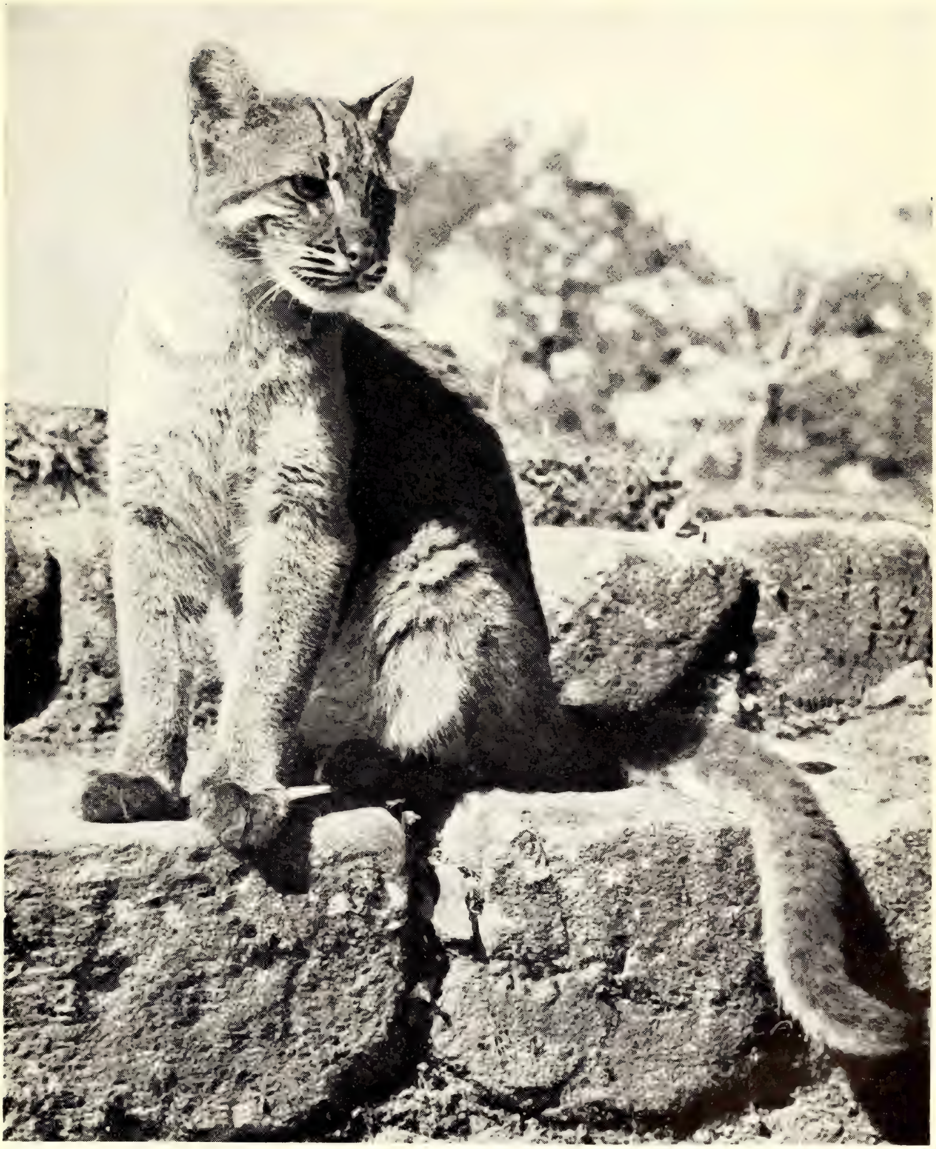
C. M. CHAUDHRI,
I.F.S. (Retired)

[The Editor of *The Pioneer* has been unable to trace any reference to a report of the tiger at any time between July 1959 and February 1960. Can any reader give us more information about this tiger?—EDS.]

3. SOME NOTES ON THE GOLDEN CAT, *FELIS TEMMINCKI* VIGORS & HORSFIELD

(*With two plates*)

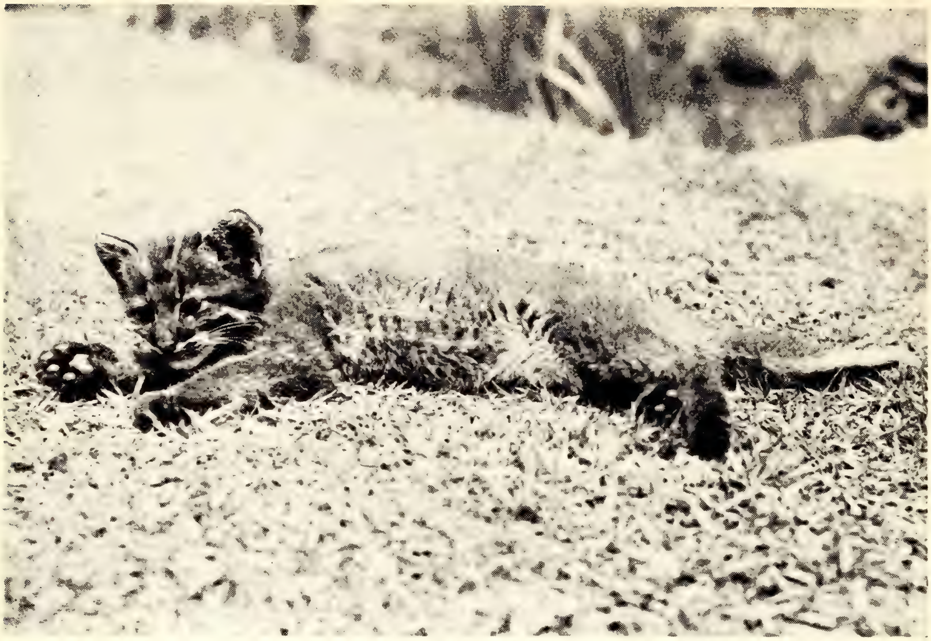
This beautiful cat is found in Nepal, north-east India, Burma, and south-east Asia down to Sumatra; Tibet, Szechuan, and (?) upper Burma; and southern China. Ellerman & Morrison-Scott list three subspecies in these three geographical areas respectively: *F. t. temmincki, F. t. tristis,* and *F. t. dominicanorum.*



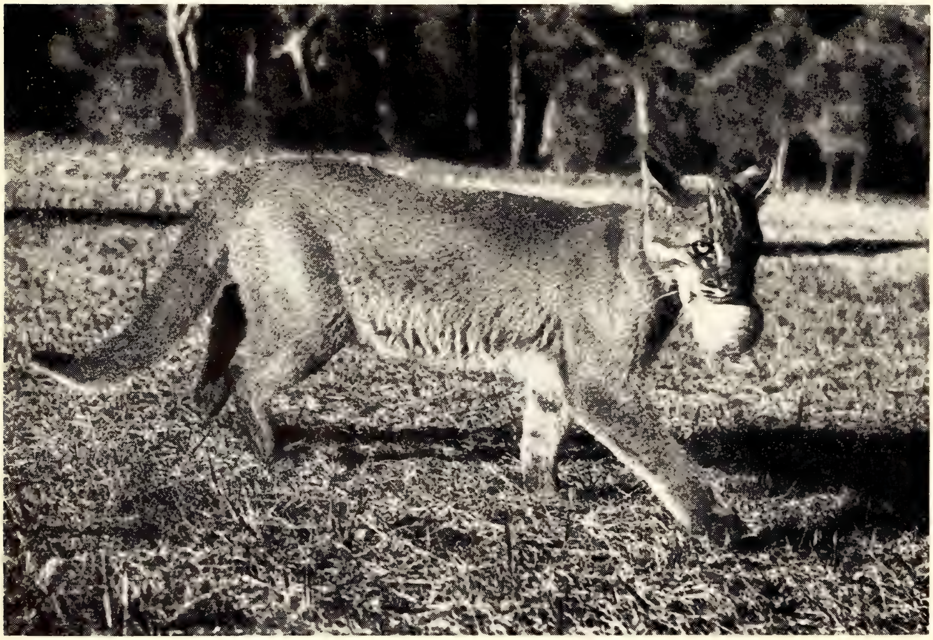
Felis temmincki temmincki

Perhaps the most handsome and brilliantly coloured of all the smaller cats

Photo : E. P. Gee



As a kitten, he was dark brown and fluffy



About three-quarters grown. His size can be gauged from the tennis ball he is retrieving

Photos : E. P. Gee

F. temmincki is extremely variable in coloration, and the typical race *F. t. temmincki* varies from very dark brown (even black) to rusty red or chestnut, ochreous-tawny, and grey. There are prominent striped markings on the face and cheeks, with faint markings on the chest and under parts. The tail is dark above and whitish below. This is a large cat, the length of an adult male being 4 ft. 2 in. (1.27 m.) including the tail.

This cat has very seldom been observed in the live state. One was seen and shot at Maymyo over a calf it had killed, and another was speared at Victoria Point, Tenasserim, while feeding on a buffalo calf. A pair of them were shot at Shilingkhet (also in Burma?) while feeding on a buffalo calf. In the Lushai Hills (of Assam) it is said to live among rocks, while in the Mishmi Hills (of N. E. F. A.) the female is said to lie up in hollow trees with her two young ones.

Sterndale quotes Hodgson to the effect that his first specimen 'was caught in a tree by some hunters in the midst of an exceedingly dense forest. Though only just taken it bore confinement very tranquilly, and gave evident signs of a tractable disposition, but manifested high courage, for the approach of a huge Bhotea dog to its cage excited in it symptoms of wrath only, not of fear.'

E. O. Shebbeare tells me that A. W. Pullan once kept a Golden Cat in captivity, and eventually presented it to the London Zoo where it died of feline distemper. It was said to be very tame, and was 'grey with darker mottling'.

In April 1960, while in Goalpara town in western Assam, I found a tiny kitten in the shop of an animal dealer, and instantly recognised it as a kitten of *F. t. temmincki*. After much bargaining I acquired it. I was told by the dealer that it and two others had been brought from the Garo Hills near by in February. They must have been found when very young indeed as this one had been in the dealer's possession for a month and was still very tiny. The other two had been sent to Calcutta but had both died on the way.

I took the kitten to my house in Upper Shillong, where he immediately made himself at home both inside the house and also all over the garden. Tishi, as he was called, proved to be remarkably tame and intelligent. He quickly came to know the servants and all the windows and doors of the rooms. He would come instantly when called, even without a chance of getting food, and would follow me everywhere. Each time I passed a tree he would leave me, dash up the tree almost to the top, dash down again and catch me up in time to do a repeat performance at the next tree. He seemed to be equally at home in a tree as on the ground—a pointer to the habits of this cat in the wild.

Tishi used to suckle the lobes of my ears, both as a kitten and even when almost fully grown up, over 3 ft. 9 in. (1.15 m.) in length. When he was bigger, I had to discourage this habit, as he sometimes became over-enthusiastic. So instead he developed the habit in later months of springing up on to my shoulders clawlessly, and licking my head. If I were to sit down, he would be in my lap immediately, and would start treading with his paws and forming saliva at the mouth. There is no doubt that, as he had hardly (if ever) seen his own mother, he came to regard me as his own kind, as a sort of father and mother combined.

As a kitten Tishi had been dark brown and fluffy. After a few months he began to change colour, and by November had grown into a strikingly handsome and truly golden cat. Everyone who saw him remarked on his brilliant colouring, as well as on his extraordinary tameness and devotion to me. Right up to the end of his stay with me, he rarely showed any signs of temper and was almost invariably well behaved and docile.

In the late afternoons he used to go 'hunting' in the forest below my house, as much as a mile away. Sometimes he even entered villages. But an hour or so after dark we used to call him, and within a very short time he was back for his evening meal and to be shut up at night—for his safety.

He would play for hours with the other cat, with the dogs, with himself: and above all he loved to have a tennis ball to catch six feet up in the air and bring back to hand—a veritable 'golden retriever'.

As there had been no chance of getting a mate for such a rare creature, and in order to improve the chance of his becoming and remaining tame, I had had him castrated in July. Then, when the following January (1961) came round and I was about to go on a trip to south India, it became a problem what to do with him. He could not be left behind with the servants. Every day I was afraid that a Khasi arrow might find its mark in him, or that he might get run over on the main road outside my garden. There was only one solution: Tishi must go to a zoo.

As there is no fully established hill zoo in India available to take a golden cat, a creature of the mountains and forests, I made arrangements with the London Zoo. On January 16th 1961 Tishi travelled the 6000 miles (9700 km.) by air to his new home, where he thrives. In his letter dated May 3rd the Curator of Mammals, London Zoo, wrote: 'Tishi has settled in splendidly and is in marvellous condition. He is a superb exhibit . . . We have already recorded a television programme . . . in which Tishi featured and I must say he looked magnificent when I saw the recording that was made.'

EVERGREEN COTTAGE,
UPPER SHILLONG, E. P. GEE
ASSAM,
May 28, 1961.

4. WHAT DO LARGE PREDATORS IN THE FOREST LIVE ON?

In January 1961 Mr. C. E. Norris, of Pingarawa Estate, Namunukula, Ceylon, wrote to us commenting on Mrs. Jamal Ara's estimate of the large predator population in her ecological survey of the Hazaribagh National Park (*J. Bombay nat. Hist. Soc.* **57**: 325-338 at p. 334). He pointed out that, at an assumed killing rate of one per week per predator and a recruitment rate of 20% per year for the large herbivore population, there would have to be a herbivore population of $20 \times 52 \times 5 = 5200$ to feed the ten tigers and ten leopards estimated as living in the Park, whereas the estimate of the deer population of the park is only 235. Mrs. Jamal Ara replied by calculations showing the absurd results that followed from the assumptions on which Mr. Norris's figures were based. For instance, the Palamau Forest Division in Bihar State, estimated by the Forest Department in the 1930s to have a tiger population of 35 and perhaps a leopard population of 25, would require for their maintenance a herbivore population of $60 \times 52 \times 5 = 15{,}600$, a figure that even the most ardent admirer of the richness of Palamau forest life would not accept as possible. Similarly, the population of 250 lions recently estimated to live in the Gir Forest would require a herbivore population of 65,000. As a result of this correspondence Mr. Norris has re-examined the question and, after consulting naturalists, game-wardens, and other knowledgeable persons in Ceylon, Africa, and India, writes that the old belief of one kill per week is 'very far from correct', and that in the course of his inquiries he has collected some 'interesting data' which he is in the process of analysing. While we await his report it would be interesting to have some other opinions too.

Bombay Natural History Society,
91, Walkeshwar Road,
Bombay 6,
July 29, 1961.

EDITORS

5. COMMUNAL DISTRACTION DISPLAY IN LARGE GREY BABBLER [*TURDOIDES MALCOLMI* (SYKES)]

A pair of Large Grey Babblers [*Turdoides malcolmi* (Sykes)] breed regularly in a solitary thorny tree in my compound here. On 19 May 1961 there were four fledglings in the nest, being fed by the parents while the rest of the flock of babblers from time to time would gather close by watching for danger and giving alarm on sighting a crow, or mongoose, or pariah kite. On 25 May 1961 one of the fledglings flew out of the nest and probably perished in a heavy rain storm which occurred that evening. Another fledgling was missing after the storm. On 29 May 1961 the two remaining fledglings left the nest and hopped about on the ground, either following the group of babblers or being followed by them. As the fledglings were at the mercy of a mongoose living close by, the babblers defended the young in a group, fluttering their wings and guiding the young ones in the direction they ought to follow. The whole flock of 8 babblers would surround the fledglings and flutter their wings. The babblers appeared to be acting as a group, attracting attention to themselves and distracting likely enemies from the young, and also somewhat guiding the young. During my few days' observation I noticed that only the parents fed the young, and the rest of the group cordoned the young ones when on the ground and were constantly on the look out for danger. The group of birds now and then fluttered their wings and often babbled in unison. When the group left for feeding, one pair of babblers which I recognised to be the parents of the fledglings remained with the young. Although communal feeding of the young is possible, I did not see it being done in this instance.

Dil Bahar,
Bhavnagar,
June 6, 1961.

R. S. DHARMAKUMARSINHJI

6. THE MOUSTACHED SEDGE WARBLER [*LUSCINIOLA MELANOPOGON* (TEMMINCK)] AND THE YELLOW BITTERN [*IXOBRYCHUS SINENSIS* (GMELIN)] : ADDITIONS TO THE BIRDS OF KUTCH

At the BNHS/WHO Bird Migration Study camp at Wanoti about 9 miles north of Mandvi, Kutch, 10th to 26th March 1961, no less than six Moustached Sedge Warblers, *Lusciniola melanopogon* (Temminck), were trapped in bird nets, all singly on different days. The only previous record from the whole of Gujarat is of Dr. W. Koelz from Sihor near Bhavnagar. It would seem from the above that this sedge warbler is not an uncommon winter visitor to Kutch, but escapes notice in the thick reed beds it frequents.

A Yellow Bittern, *Ixobrychus sinensis* (Gmelin), was noted and later collected by P. W. Soman. The only record from Gujarat is that of Butler from Deesa, where he found a few pairs breeding in 1876.

Jasdan,
Saurashtra,
March 29, 1961.

Y. S. SHIVRAJKUMAR

[A specimen of *Lusciniola melanopogon* collected has the wing 62 mm. and is no doubt of the eastern race *L. m. mimica* Madarász.

The Yellow Bittern, *I. sinensis*, has not been specifically recorded from Kutch but in *J. Bombay nat. Hist. Soc.* Vol. 1, page 143, is published a list of 102 specimens presented by A. H. T. Newnham, which in the course of the Annual Report published on page 89 of the same volume are said to be collected from Bhuj, Kutch. This includes two specimens of *I. sinensis* though they no longer exist with us.

The Yellow Bittern is said to occur all over India and Ceylon, east to South China through Burma, the Malay States and Archipelago, to Celebes. In India, however, it has a more restricted distribution. While common in Bengal, Assam, and parts of Burma, the other records from India are restricted to the west, i.e. Sind, Deesa (Gujarat), Bombay, and Malabar, in all of which places it is believed to breed.—Eds.]

7. RUFOUSBELLIED HAWK-EAGLE, *LOPHOTRIORCHIS KIENERII KIENERII* (E. GEOFFROY) IN NORTH KANARA

While I was on tour in North Kanara as the Wild Life Preservation Officer of the pre-1961 Bombay State, I had occasion to visit the Dandeli Game Sanctuary which was then being completed. The area of the Sanctuary is about 80 sq. miles and consists of moist deciduous forest containing valuable teak forest but mostly overgrown with bamboos and other trees. The area in some parts is hilly with deep ravines. A beautiful view of this type of country is seen at Sykes's Point and it was here that I saw a Rufousbellied Hawk-Eagle [*Lophotriorchis kienerii kienerii* (E. Geoffroy)] glide past me and then rise up at an acute angle disclosing the upper and lower parts of the body and wings. The first impression of the bird's coloration is much like that of the Indian Shahin, dark slaty upper parts to the lores and ear coverts but with a light patch on the lower side of the primaries, the lower wing appearing grey but the axillaries and under wing-coverts looking rufous; breast whitish with dark stripes and belly deep chestnut; the small crest was also seen. While gliding in air currents the bird was seen rising and falling with half closed wings sometimes at steep angles. I had a number of glimpses of the bird through binoculars on Monday, 19 December 1955. I also heard the grey junglefowl cackling when this Hawk-Eagle swooped low over the forest roof.

26, Lotus Court,
Jamshedji Tata Road, R. S. DHARMAKUMARSINHJI
Bombay 1,
June 2, 1961.

[This race occurs in Ceylon and SW. India, the northernmost record so far being from Settihalli, 2500 ft., Shimoga, Mysore, where Dr. Sálim Ali saw a single bird between 25 Jan. and 2 Feb. 1940 (*J. Bombay nat. Hist. Soc.* **44** : 20).—Eds.]

8. PELICANRY AT KUNDAKULAM, TIRUNELVELI DISTRICT

In his article on the Grey, or Spotbilled Pelican (*Pelecanus philippensis* Gmelin) in the *Journal of the Bombay Natural History Society* (Vol. 57, page 246) E. P. Gee writes of a small pelicanry in the village of Kundakulam, Tirunelveli District, in the extreme south of Madras State. He says that since the visit of C. G. Webb-Peploe in April 1944 (Vol. 45, page 426) there is no further news of this diminutive colony of pelicans.

On January 7th 1960 I visited Kundakulam. On that occasion, although about a hundred Painted Storks [*Ibis leucocephalus* (Pennant)] had arrived and were inspecting sites for nesting, I saw only one pelican. Women from the village told me subsequently that about a week after my visit further pelicans arrived.

On 22nd March of this year a friend visited Kundakulam and brought me back the following information.

Pelicans had built in about five trees but there were no young in the nests yet. There were two or possibly three nests in a tree along with nests of Painted Storks in which there were already young birds. There were also many nests of Night Heron and Little Egret.

Some of the trees on which the birds nest are quite low. They include *Azadirachta indica*, *Thespesia populnea*, and *Delonix elata*.

The headmen of the village still protect the birds and their women-folk spoke with scorn of a village of which they had heard where the people had so ill-treated their birds that 'not even a sparrow is to be found there now!' The women also said that a few years previously the birds came at their customary time but, finding no water in the tank, they circled round for several days and then left. They did not know where the birds nested that season but the following year they returned to Kundakulam in their usual numbers. As the Kundakulam tank is now fed by a channel from a newly constructed dam in the mountains to the west it is more likely to be filled in future even in years of poor rainfall.

In January 1960 I saw the nest of a pair of Black Ibis, *Pseudibis papillosa* (Tem.)[1]. The nest was high up in a palmyra palm on the edge of the village several hundred yards from the nearest tree on which the Painted Storks were nesting.

DOHNAVUR,
TIRUNELVELI DT.,
SOUTH INDIA,
March 4, 1961.

MARGARET E. WILKINSON

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[1] This appears to be first definite record of the Black Ibis, *Pseudibis papillosa* (Tem.), breeding in south India.—EDS.

9. FOOD OF THE RUDDY SHELDUCK, *TADORNA FERRUGINEA* (PALLAS)

On pages 273-4 of Vol. 53 of our *Journal* there was some discussion regarding the statement that the Ruddy Shelduck [*Tadorna ferruginea* (Pallas)] feeds on carrion.

Though Meinertzhagen was quoted as having seen them lopping up bits of a putrid horse and as many as 20 birds gorging on a corpse in the Ganges, the stories of carrion-eating were generally accepted as erroneous. In an attempt to obtain a clarification we wrote to Col. Meinertzhagen and his reply reads in part: 'It is quite possible that the Ruddy Shelduck which I saw feeding on carrion in India were feeding on maggots, but I'm quite sure they were snatching meat, perhaps to expose maggots.'

It may therefore be interesting to record that P. S. Nazaroff in HUNTED THROUGH CENTRAL ASIA (1932) at page 246 says: 'I have found their nests even in fresh Kirghiz graves, and as they often feed on carrion, joining in with vultures and crows, it is better to cut them out of the list of edible game, especially as the meat is tough and stringy.'

Andrews in NEW CONQUEST OF CENTRAL ASIA (1932), p. 49, refers to experiences in Tuerin in Outer Mongolia. He says: 'No water within many miles but about 20 had taken up their residence among the granite rocks. All day long we could hear their mournful notes as they circled about camp and contended for a favourite roosting place on one of the highest peaks. Often we would see one silhouetted against the sky on the very summit of a ragged pinnacle, looking more like an eagle than a water bird. We found them throughout the desert. There, I suppose they feed as do cranes upon grasshoppers and other insects, but I am sorry to say that I surprised one pulling lustily at the decaying flesh of a defunct camel.'

Bombay Natural History Society,
91, Walkeshwar Road,
Bombay 6,
July 26, 1961.

EDITORS

10. A LATE DUCK RECORD ?

During our recent holiday in Naini Tal, my children and I noticed three different species of duck on the lake in May. A small flock of about 10 Tufted Pochard [*Aythya fuligula* (L.)] (both sexes) kept strictly to themselves; but two Redcrested Pochard [*Netta rufina* (Pall.)] drakes were usually not far away from a flock of about 8 Common Pochard [*A. ferina* (L.)] (both sexes). All these birds appeared to be wild, and were certainly under no sort of restraint or protection. They showed almost no fear of mankind, and would allow a fairly close approach by boat. They were invariably to be seen along the Mall shore of the lake; this, though of course much noisier and more populous than the opposite shore, probably affords a richer food supply, thanks to all the drainage ditches that empty from it into the lake.

All these duck were to be seen daily, right up to 16 May, on which date we reluctantly left this delightful hill station. I am sending this note, in case this constitutes a 'late record' for the lingering of duck in Indian waters.

MAIDSTONE,
PANCHGANI,
SATARA,
June 14, 1961.

T. GAY

[As a general rule these duck commence nesting in late April or early May. None of them breed in India and the dates reported by Mr. Gay are of interest.—EDS.]

11. NOTES ON BIRD MIGRATION DURING A VOYAGE FROM ENGLAND TO INDIA IN SEPTEMBER 1960

Last year we returned to India on board S. S. *Carthage*, leaving Southampton on 16 September and arriving in Bombay on 4 October. Bird migration in the eastern Mediterranean, the Red Sea, and the Indian Ocean was in full swing; perhaps the following notes might be of interest to other travellers.

We left Southampton in a dense fog and continuous rain. I have seldom been so contented to leave my native land. The white cliffs were totally invisible and we soon ran into a heavy gale which continued until 19 September when we emerged into the Spanish sunshine. The usual gulls and shearwaters were seen. Quite a number of Great Skuas (how this species is increasing its numbers!) and a few Arctic Skuas harrying flocks of Sandwich Terns, but no small migrants rather to my surprise. In fact we saw none, except a single Turtle Dove near Gibraltar, and a swallow off the Algerian coast, until the 22 September when we passed Malta in heavy rain. Swallows then began to appear in small numbers, and these increased rapidly, together with wheatears etc. as we approached Port Said, which we reached at midnight on 24 September. We left at dawn for the Suez Canal. I was not on deck as early as I might have been and bitterly regretted my laziness on hearing that I had missed several hundred flamingos! The country on both sides of the Canal was alive with birds. Thousands of waders swarmed along the little irrigation canals. Greenshank, Redshank, and Ringed Plovers could be identified, but the great majority could not. Shrikes, Doves, Kestrels were numerous. Then I saw what looked like a black falcon on the ground. At first I could not believe my eyes until I saw another and then another and realised I was looking at the Redfooted Falcon. The brilliant red legs and red eye patches could be clearly seen. On consulting Peter's invaluable FIELD GUIDE I read that they often hunt insects on the ground. During the next two hours others were seen, females as well as males.

Another excitement was a flock of Lesser Kestrels. The late Sir Norman Kinnear had asked me to look out for these birds in Nepal, and I sometimes wondered if I could have overlooked them and confused them with the common Kestrel. Now that at last I did see them it was clear that no mistake was possible. These birds are much brighter, smaller, and in flocks. They called and chattered and behaved in quite a different manner from the Kestrel. I am now quite certain that I have never seen these birds in Nepal, nor anywhere else in India.

Caspian Terns were also common in the Canal, and many other terns, some with black wings.

In fact it was utterly frustrating to be swept inexorably through this paradise of bird life, on into the desert country further south where little life was seen.

In the Red Sea there was also much migration and even in the Indian Ocean where I had expected to see little except the Phalaropes, which were there in their thousands. We also saw herons, swallows, Short-toed Larks, and doves. We wondered how many of these luckless birds would survive. I had never realised before what terrible wastage must occur during the migrations.

A detailed list of species seen is given below:

Ardea cinerea Grey Heron.

A single heron was seen south of Crete, on 23 September, flying in a south-easterly direction.

On 29 September a pair of these birds appeared—we were then about 5 hours out of Aden harbour. They flew very close to the ship and made several unsuccessful attempts to land on the mast and upper decks. They appeared tired and one bird had several primaries missing. They continued with us for about an hour, frequently flying off to the north and then returning to the ship. It was almost dark when they finally left us and flew off in a NNE. direction. The captain said that land would be about 50 miles away in that direction. They were flying strongly so I hope they made it, but what could they have been doing there at all. I did not know that herons were migratory, except locally.

Still stranger was the report of another passenger (who was a very reliable observer) that he had seen two herons in the middle of the Indian Ocean. We were then rather nearer Bombay than Aden. He said they were flying due south and took no notice of the ship. I suppose these last might have been Reef Herons, but even so it was surely extraordinary for them to be so far from land.

Oceanites oceanicus Wilson's Petrel.

A few of these birds were seen north of Sokotra on 30 September. Singles and not more than a dozen altogether. None were seen as we approached Bombay.

Eagles, Buzzards spp. ?

From Suez to Aden (26-29 September) there was a continual migration of large brown raptores. They were most numerous in the Gulf of Suez where one was seen on an average every 5 minutes, and less so as we went south. In the south Red Sea perhaps only one would be noticed in 3 or 4 hours, but I saw an occasional bird up to 10 hours of reaching Aden. They flew singly. Sometimes 2 or 3 birds could be seen at the same time, but they never flew together. Some flew 20 feet or so above the water, but the great majority just above the waves. They flew steadily in a SW. or W. direction. The wind was strong from the N. or NE., so they flew either across the wind or downwind. Sometimes an extra strong gust seemed to bother them somewhat and they would turn into the wind, banking for a moment and then resume their original direction. They took no notice of the ship and were never diverted from their steady flight. Unfortunately I was unable to identify them. They appeared a uniform brown, some lighter than others. There were no bars in the wing, no white on the upper tail-coverts. The underwings could not be seen. It is very difficult to judge the size of birds at sea, as in the waste of water there is nothing to compare them with and it is hard to tell how far away they are from the observer. I am inclined to think they were eagles, some race of *A. rapax* perhaps.

Once in the middle of the Red Sea, north of the Apostles Islands, I saw two buzzards, flying together and wheeling in great circles one above the other. They had the moth-like pattern of a buzzard on their underwings and seemed smaller than the others.

Accipiter nisus Sparrow-Hawk.

A very large sparrow-hawk came on board the evening before we reached Aden, 28 September. It sat on the mast but frequently flew off behind the ship, where it circled, sometimes disappearing behind the low rain clouds, but it always returned flying rapidly after the ship, and after alighting for a minute on the rigging in the stern would fly up to the cross-trees on the main mast, and was still there when darkness fell. It was so large that I might have thought it a Goshawk, if the long yellow brittle-looking legs had not been so clearly those of an *Accipiter*.

Next day as we left Aden in the afternoon another but much smaller Sparrow-Hawk followed the ship, alighting in exactly the same place. It also was still there at dusk but gone in the morning.

Circus aeruginosus Marsh Harrier.

A single male was seen in the north Red Sea, just north of the islands, The Brothers. It was flying west.

Falco vespertinus Redfooted Falcon.

In the Suez Canal about 3 hours after leaving Port Said, on 25 September, I saw 5 males of this species together in a fallow field. They were on the ground. Later 2 females on telegraph wires, then another single female. Later another group of 3 males on the ground with a single female.

Falco naumanni Lesser Kestrel

A flock of 15 of these birds was seen in the Canal. They were restless flying about and then returning to a stunted tree on which they congregated. They were very noisy, screaming and chattering and behaving very differently from the Common Kestrel. They were also much brighter. Later I thought I saw another flock but a good distance away and I could not be sure.

Falco tinnunculus Kestrel

Very common all along the Canal, but I could not of course tell what proportion were on migration. I never saw one of these birds at sea.

Tringa totanus, T. nebularia, Calidris alpina

Greenshank and Redshank formed part of the huge flocks of waders near Port Said. There were also I think large numbers of Dunlin, and certainly Ringed Plover, but I could not tell which species.

Phalaropus lobatus, P. fulicarius

Vast concentrations of phalarope were seen north of Sokotra on 30 September. Visibility was poor and no land could be seen, but from the chart I thought we were due north of the island. We began to run into little groups of these birds at about 11 o'clock. By midday there were thousands of them. Some of the flocks must have contained 200 to 300 birds, but mostly they were in groups of 20 to 70 or so. They were often sitting on the water, riding very high and looking incredibly fragile for ocean birds, but unfortunately the ship always frightened them into flight before one could examine them closely.

Twice single birds came on deck; these had black legs and very fine black bills so were presumably *P. lobatus*, the Rednecked Phalarope. On the water I could not tell to which species they belonged. For three hours we sailed through great numbers of the birds. Then the numbers grew rapidly less and by evening only small groups of 5 or so were occasionally seen. Next day we passed some single birds and a few small groups and these were all flying west so perhaps on their way to joining the large flocks north of Sokotra.

Streptopelia turtur[1] Turtle Dove

Doves formed a large proportion of the migrants seen. One was seen near Gibraltar, and small numbers in the eastern Mediterranean. In the Red Sea they were seen all the time, though there were seldom more than 5 or 6 round the ship at one time. These last appeared very pale, but perhaps this due only to the brilliant light which makes everything appear to be drained of colour. None were seen after leaving Aden until 24 hours out of Bombay when doves again appeared but sat on the rigging too high for identification. Migrating Turtle Doves are much attracted by a ship, and sometimes seem unable to decide to leave it even when land is plainly visible. I have often seen dead birds floating past the ship, although others will rest for a moment and continue on their way.

---

[1] This species does not occur in India.—EDS.

Merops apiaster European Bee-eater

This lovely bird came on board on 27 September, south of the Gulf of Suez. It sat on the rigging and was very tame, allowing passengers to come within a few feet of it. It remained on board till dusk fell but was gone in the morning.

Upupa epops Hoopoe

The Hoopoe was only seen once flying alongside the ship near Port Said on 24 September.

Hirundo rustica Swallow

No swallows were seen in the Atlantic, and only one in the western Mediterranean off the Algerian coast. On 22 September as we approached Malta swallows were seen in small numbers, and often sat on the rigging to preen themselves. There were many young birds with short tails. On leaving Malta a small party (5 birds), which had been with us all day, took off in a NE. direction. Between Malta and Port Said swallows were abundant and there were always numbers round the ship. Several birds sat on the rigging with closed eyes and one collapsed and died. It appeared in perfect condition.

All down the Red Sea swallows were seen, but not in great numbers usually 2 or 3 together. They became fewer as we went south, and none were seen in Aden.

Two days out from Bombay 3 birds came on board and remained with us for a few hours before taking off in a due south direction. I wondered if these had any chance of reaching land. 12 hours from Bombay a single bird alighted on the rigging for a minute and then flew on. It was definitely *rustica* not the eastern race. Near Bombay I saw others but they did not come very close.

Hirundo daurica Redrumped Swallow

Several seen on 23 September south of Crete. A few were also seen in the Canal and north Red Sea.

Delichon urbica House Martin

Two martins were seen south of Crete. They flew round the ship and dipped low over the water exactly as if they had been sipping it, though I could not see if they actually touched the water and it seems unlikely. Martins were also seen occasionally in the Red Sea. 2 just as we passed the island the Apostles. None after that.

Riparia riparia Sand Martin

One seen with swallows near the Apostles Islands in the Red Sea.

Oenanthe oenanthe Wheatear

None seen in the western Mediterranean, but frequently in the eastern Mediterranean after Malta. One spent the night in the bar. None in the Canal nor after that.

Calandrella brachydactyla

Short-toed Larks were seen 24 hours out of Bombay. We first saw them sitting high on the cross-trees of the mast, 3 together. During the day more were seen. They came down on to the decks and drank water put down for them by passengers. They were very tame. I never saw any leave the ship and when we sailed into Bombay on 4 October, there were still numbers on board. I could not tell to which race they belonged. The short hind claw was clearly visible. It is interesting to see what considerable migration takes place out at sea when one would think it much easier for birds to follow the coast line.

BRITISH EMBASSY,
KATHMANDU, DESIRÉE PROUD
NEPAL,
March 21, 1961.

12. THE EGGS AND FLIGHT OF THE GECKO *PTYCHOZOON KUHLI* STEJNEGER FROM CAR NICOBAR

(*With one text-figure*)

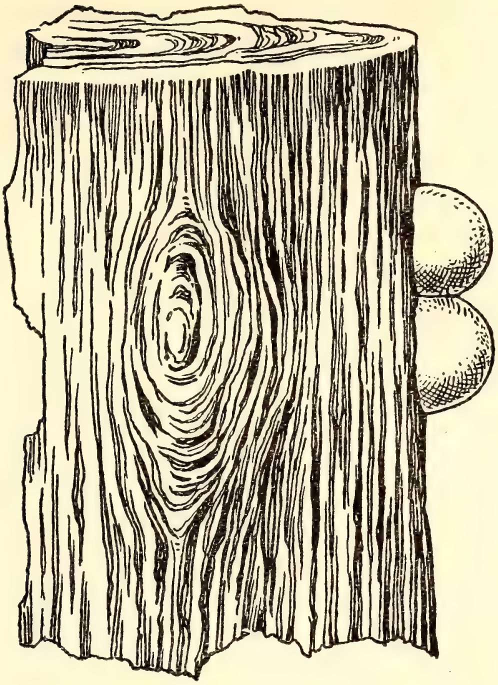
The eggs of *Ptychozoon kuhli* Stejneger are unusual in two features: they are hemispherical in shape with a flat, circular 'base', and they are often laid (at least under natural conditions) on surfaces vertical to, and above, the ground. I have seen a few pairs of such eggs laid on bark of trees about 1½ to 2 ft. (45 to 60 cm.) above ground in Car Nicobar Island. These eggs, which are easily mistaken for mushrooms and thus overlooked, are firmly attached to the bark by a thick layer of a coarse cementing substance which often overflows the boundaries of the 'base' of egg. In a pair of eggs collected by me from the bark of a tree at Passa Bridge in Car Nicobar on 23 March 1959, the diameter of base measured 15 mm., while the maximum height was 11 mm. The shell was dirty white in colour, and when broken open, one of the eggs yielded an almost full-grown embryo of *Ptychozoon*.

Tweedie (1954) has given an excellent photograph of a pair of eggs of *Ptychozoon kuhli* collected from the bark of a tree in Malaya. Those observed by me in Car Nicobar (see Text-fig.) were similar to Tweedie's photograph.

Cantor (1847), who was the first to record the eggs of *Ptychozoon*, refers to a female that deposited a *single egg of a spherical form*, about half an inch in diameter, soft and of a yellowish white colour. Bauer (1885), reporting later, mentioned a captive female of this species from Java that laid a pair of eggs in the box in which she was kept. He says nothing about the shape of the eggs but records the long incubation period of the eggs which, laid in November, did not hatch out until the middle of the following May. Annandale (1904) refers to the eggs of *P. homalocephalum*, which are laid two at a time and which 'adhere to leaves and tree trunks'. Barbour (1912) also remarks: 'The two small white eggs of *Ptychozoon* are always found stuck together in pairs, usually against the wood under the bark of trees'.

The period of incubation of the eggs of *Ptychozoon* appears to be variable. According to Bauer (1885) it should be about six months, but Tweedie (1954) gives the actual time between laying and hatching of two eggs by a captive female kept by Mr. H. J. Kitchener as 73 days. The pair photographed by Tweedie hatched out 67 and 68 days after being found, and according to Mr. C. S. Ogilvie, who actually got these eggs, they were fresh at the time of collection. It appears that the egg-laying period in this species is November-December and the period of incubation may vary from about ten weeks to more than five months. Annandale (1904) thinks that the hard shell of the egg is impermeable to fluids. Its habit of attaching the eggs to the bark of trees, leaves, etc., and the long incubation period may account for the presence of this species of gecko in the Andaman and Nicobar group of islands. This is possible because logs of wood, bamboos, etc. from the Burmese and Malayan coasts quite often find their way to the Andaman and Nicobar Islands drifting along with the current.

Ptychozoon is a genus of gecko which, among other features, is characterised by the possession of widely-webbed digits and lateral cutaneous expansions of head, body, and tail (the last is frilled). The function of these expansions was subject to much speculation till recently. Cantor (1847) thought that these membranous expansions act like a 'parachute', helping the animal in



Text-fig. Eggs of *Ptychozoon kuhli* Stejneger

'flying' from one branch to another. Boulenger (1908) confirmed Cantor's views by recording a specimen 'caught by a native in the act of flight'. Annandale (1905), however, disputed the flight theory. He opined that these membranes, which lie curled round the body, help to conceal the animal in its surroundings. Barbour (1912) agreed with Annandale and said: 'As for flying with such weak supports this struck us at once as both being impossible and ridiculous. Individuals were teased into jumping from a table, were dropped from several feet up in the air, and were in every way induced to try to use what has so often been called their parachute. They never did this once.' Smith (1935) rejected Annandale's contention and believed in Cantor's view, suggesting that the extensions are raised by wind resistance, thereby acting as sort of 'parachutes' and thus aiding the lizard in gliding.

Recently Tweedie (1950, 1954) performed certain experiments on *Ptychozoon kuhli* to test the flight theory. He reports that these cutaneous flaps lie curled round the body when the animal is at rest or crawling, and are only accidentally expanded. They do have a procryptic value, and help the animal in making it less conspicuous against the background when expanded, but they are not an adaptation to that end. On the other hand, when launched into the air from a height the animal, after a drop varying from 2½ to 5 ft. (.75 to 1.50 m.), invariably glides, always in the direction of the wind, making an angle of 52°-53° from the vertical. While gliding the lateral cutaneous expansions are widely spread, the limbs and tails are stiffly outstretched, landing on the ground like a true Flying Lizard (*Draco*). On the basis of his experiments Tweedie (1950) concludes that the dorsal pattern of coloration, in lighter and darker shades of brown, 'is very effective as an aid to self effacement on a background of bark', and the frilled tail and webbed feet enhance the procryptic effect. The lateral expansions on the head and body are adaptations for gliding alone, and in this again they are helped by the widely webbed digits and frilled tail, all of which, by offering resistance to wind, aid in the process.

As far as the procryptic nature of the dorsal pattern, the webbed feet, and frilled tail are concerned, my observations are entirely in conformity with those of Tweedie. Against a background of bark, the animal almost totally disappears and is very difficult to make out. However, I did not see any gliding by this gecko, which does not seem to be uncommon in the Car Nicobar, during my fortnight's stay there. Though Barbour (1912), failing to induce his individuals to glide, rejected the flight theory 'as both being impossible and ridiculous', Tweedie's experiments conclusively prove the gliding capacity of *Ptychozoon kuhli.* In his first experiment Tweedie launched the animal from a height of 20 ft. (6.10 m.), from the ground, while in his subsequent efforts a height of 34 ft. 6 in. (10.50 m.) was used. The descent had two components, an initial drop of 2½ ft. (.75 m.) and 5 ft. (1.50 m.), followed by gliding at an angle of 52°-53° to vertical in the direction of the wind. It is apparent that Barbour failed because he did not launch his specimens from a sufficient height, thus giving no time for the membranous expansions to be raised by wind resistance. As these membranes do not have any muscular supports, they cannot expand and shut voluntarily, and are passive like parachutes. In falling from greater heights, the wind resistance encountered is strong enough to open the membranes, thus enabling the individual to glide obviously along the direction of wind. It would thus appear that an important factor in the gliding of *Ptychozoon* is the height from which the animal launches itself into the air.

ZOOLOGICAL SURVEY OF INDIA,
CALCUTTA-12,
June 12, 1961.

K. K. TIWARI

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——— (1954) : Notes on Malayan Reptiles. No. 3. *Bull. Raffles Mus.* **25** 107-117, pl. i.

13. THE COMMON CALOTES OR BLOODSUCKER LIZARD [*CALOTES VERSICOLOR* (DAUDIN)] AS A PREDATOR OF BIRDS

During the recent (March 1961) Bombay Natural History Society/World Health Organization Bird Migration work at Wanoti (Bhuj, Kutch) I twice had occasion to rescue from a Common Calotes or Bloodsucker Lizard [*Calotes versicolor* (Daudin)] birds caught in one of our nets stretched out near a pond. In the first instance it was a Bluethroat (*Erithacus svecicus*). Little damage was done as I was present when the lizard ran along the ground and seized the bird which was caught low down in the net.

A few days later I heard cries of distress from the same net and saw that a *Calotes* had caught a Baya (*Ploceus philippinus*) in similar conditions. The bird was bitten on the forehead and the wing but flew away when released. The lizard, probably the same individual, was secured and found to be a male measuring 16 inches (405 mm.).

There do not appear to be many specific records of this lizard catching birds though I understand that it is commonly known to take eggs and nestlings of the smaller species.

Bombay Natural History Society,
91, Walkeshwar Road,
Bombay 6,
April 27, 1961.

M. J. PEREIRA

14. OCCURRENCE OF THE PHOORSA, *ECHIS CARINATA* (SCHNEIDER) ALONG THE MALABAR COAST SOUTH OF KARWAR

According to Smith [(1943) FAUNA OF BRITISH INDIA, REPTILIA AND AMPHIBIA 3, SERPENTES] the Phoorsa, *Echis carinata* (Schneider) (Malayalam : Churutta) is a common snake, inhabiting the whole of India south of the Ganges but absent from Bengal and the coast strip west of the Western Ghats, south of Karwar. It is well known as a desert-loving snake. The Bengal and Malabar coasts get an abundant supply of rain, which would naturally act as a barrier to the entry of *E. carinata* into these areas. However, the snake is not altogether absent along the Malabar Coast, being fairly common in arid hilly regions especially from November to March, and rare or even absent in the plains. One specimen was collected at Devagiri (300 ft. = 90 m. above sea-level), Calicut, Malabar. Its lepidosis is:

Costals at three head-lengths behind the neck	23
Costals at midbody	25
Costals at three head-lengths in front of the vent	23
Ventral shields	139
Subcaudals (single)	28
Anal	1

Department of Zoology,
St. Joseph's College,
Devagiri, Kovur, Calicut,
March 23, 1961.

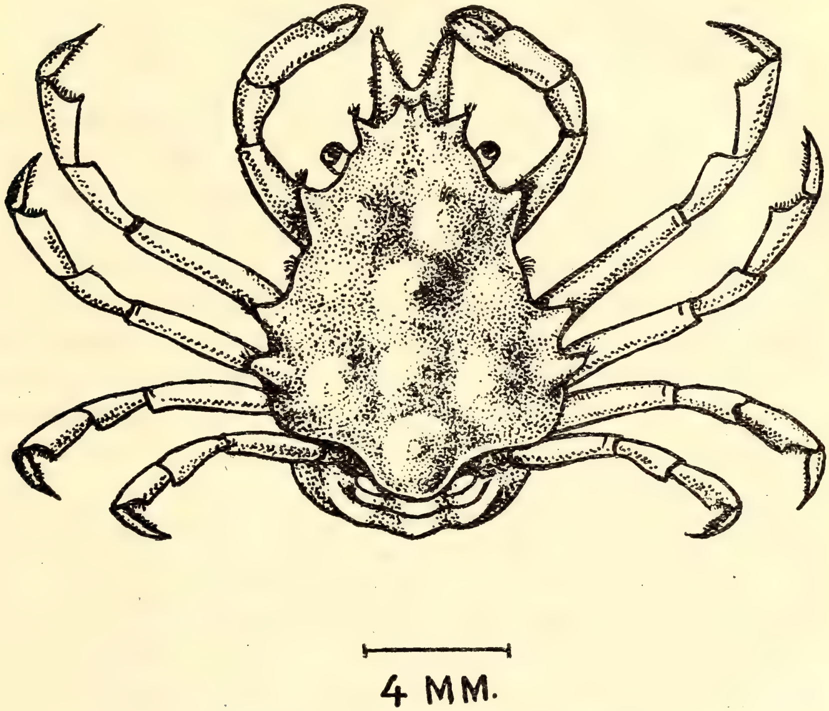
K. G. ADIYODI

[Enquiry at the State Museum and the Zoo at Trivandrum and Trichur, and the Government Museum, Madras, reveals that they have no specimens from this area.—Eds.]

15. EXTENSION OF RANGE OF THE CRAB, *ACANTHONYX LIMBATUS* MILNE-EDWARDS, TO INDIAN WATERS[1]

(*With one text-figure*)

In a collection of crabs made at Okha port (Gujarat State; 22° 28′ N., 69° 05′ E.), the author came across a single female specimen of an Oxyrhynch crab. This was identified as *Acanthonyx limbatus* Milne-Edwards. The characters of this crab are given below.



Acanthonyx limbatus Milne-Edwards

Female, dorsal view

The carapace is sub-triangular, its greatest breadth being $\frac{3}{4}$ the length excluding the rostrum. The rostral horns are one-fifth the carapace length, and bear hooked setae apically and along the inner margins. In addition to the supra-ocular tooth, there are three well-developed lateral teeth on each side of the carapace, decreasing in size backward.

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[1] Communicated by the Director of Fisheries, Maharashtra.

There are seven tubercles on the dorsal surface of the carapace arranged in the following manner: three tubercles forming an inverted triangle on the gastric region, one cardiac, one intestinal, and one each on the mesobranchial regions. Hooked setae occur in front of the anterior pair of tubercles on the gastric region, on the tips of all the teeth and the rostral horns, and on swellings on the lateral margins between the first and second pairs of lateral teeth.

The abdomen has five segments, segments 4-6 being fused.

Length of carapace (excluding rostrum) ..	12.12 mm.
Breadth of carapace (at the level of, and inclusive of, the lateral teeth)	9.75 mm.
Length of rostral horns	2.11 mm.

There is a difference of opinion about the generic position of this crab. The type-specimen was placed in the genus *Dehaanius* on the basis of the presence of seven segments in the male abdomen. However, the specimens collected in Iran have been placed in the genus *Acanthonyx*, the abdomen of these being six-jointed. The validity of the genus *Dehaanius* has been challenged, as the most important difference between the two is the number of segments in the male abdomen, and this character is not constant in the same species, and so also the degree of coalescence of the abdominal segments. In the absence of a male specimen from Okha, the author has placed it in the genus *Acanthonyx*.

This species has been previously recorded from the Reunion Islands (longitude 55° E.) by A. Milne-Edwards[1], and at Bustani and Quais (longitude 54° E.) in the Persian Gulf by Stephenson[2]. Its occurrence at Okha port (longitude 69° E.), therefore, constitutes the first record of this species from India, as well as a considerable extension of its range of distribution eastward. The specimen will be deposited in the collections of the Zoological Survey of India.

The author is thankful to Dr. (Mrs.) D. Guinot-Dumortier of the National Museum of Natural History, Paris, France, for sending photostat copies of literature not available in India, to Mr. K. N. Sankolli for donating the specimen, and to Dr. C. V. Kulkarni, Director of Fisheries, Maharashtra State, and Dr. H. G. Kewalramani, Research Officer, for going carefully through this paper.

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[1] Milne-Edwards, A. (1862) : Faune Carcinologique de l'Ile de la Réunion—in : L. Maillard : Notes sur l'Ile de la Réunion (Bourbon), Paris, second partie, Annexes, F, p. 7, pl. 17, figs. 4, 4a, 4b.

[2] Stephenson, K. (1945) : The Brachyura of the Iranian Gulf—in : Danish scientific Investigations in Iran, Part IV, p. 102, fig. 19.

TARAPOREVALA MARINE BIOLOGICAL STATION,
BOMBAY, B. F. CHHAPGAR, M.SC.
April 28, 1961.

16. 'AN UNUSUAL METHOD OF CURING SCORPION STINGS'

I was interested in Mr. Humayun Abdulali's letter of August 1st, 1960 (Vol. 57, No. 3) on the subject of curing scorpion stings.

I remember, when I was in the Army and my Division was, in 1942, in a training area in the Deccan, meeting an Irish doctor in charge of a Field Hospital who told me he had to cope with something like a hundred scorpion stings a day. He said he had been most impressed by a method he had learned locally of how to cure them. He stated that, provided the sting was on some part of the body where you could work the poison out to an extremity, such as a foot or a hand, a full cure could be achieved in relatively few minutes. All that you had to do was to bring together, on to the place where the patient had been stung, the points of—well, he said more or less anything, a pair of sharpened pencils, a couple of scissors or even two rusty nails!—and then slowly start stroking the flesh, firmly but not to the point of breaking the skin, in a downward direction towards an extremity. He said it was amazing how you could literally push the poison along quite quickly, the end of the exercise being achieved when you had brought it down to the ball of, say, a finger-tip, at which stage you could, merely by pricking the skin and exerting pressure with your thumb-nails, eject the blob of poison out of the finger with a sharp pinch.

I never had the opportunity of witnessing the curing of a patient by these means (though I was invited to do so) but that was his story.

TRIBENI TISSUES PRIVATE LTD.,
24B, PARK STREET, P. H. SYKES
CALCUTTA 16,
July 26, 1961.

17. 'NOTES ON THE BUTTERFLY GENUS *YPTHIMA*'

In our 'Notes on the Butterfly Genus *Ypthima*' in *J. Bombay nat. Hist. Soc.* (1959) **56** (1): 66-71 we said that *Y. newara* Moore should be a species separate from *Y. nareda* Kollar and not merely a subspecies, because the clasps were so different. Norman on a visit to Japan has met Professor Takashi Shirozu of Kyushu University who has informed him that he published the same opinion in 1955 (T. Shirozu in FAUNA AND FLORA OF NEPAL HIMALAYA vol. 1, ed. H. Kihara, Kyoto). If we had known of this fact we would have been glad to quote so eminent an authority.

5, UPPER WIMPOLE STREET,
LONDON, W. 1,
June 13, 1961.

K. CANTLIE
T. NORMAN

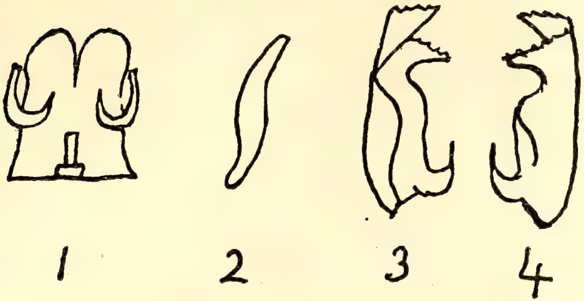
18. HESPERIIDAE. *HALPE SCISSA* SP. NOV.

(*With four text-figures*)

Found among the huge collection of Tytler in papers in the British Museum (Natural History). Taken in East Dawnas, Burma, in February 1926. The genitalia were examined by me in order to identify the specimen. They were found to be unlike any figured by Evans in plates 33 and 34 of his CATALOGUE OF THE HESPERIIDAE OF EUROPE, ASIA AND AUSTRALIA, 1949. They are drawn below.

Description of facies. Upper fore: the spots in 2 and 3 (in this case pale yellow) and the two tiny apical spots are all characteristic of the genus. No cell spot. Male stigma present. Upperhind unmarked, disc covered with tawny hairs. Underhind unmarked. F. 16 mm. Termen equal to dorsum. Cilia grey. Antennal club above not whitish or yellowish ringed before apiculus.

Genitalia. Fig. 1 shows the uncus with a narrow deep cleft like *luteisquama*. Fig. 2 shows the aedeagus. It is bent towards the clasps, not towards the uncus. Fig. 3 is the inside of the left clasp and Fig. 4 the outside. Footstalk unusually long, more slender than in any other species, terminating in a long narrow point. It is not serrated. The upper crest of the cuiller is serrated on its crest, which is wider than any other flat-topped species and of a different shape. The



Text-figs. 1-4. *Halpe scissa* sp. nov.
1. uncus ; 2. aedeagus ; 3. inside of left clasp ; 4. outside of left clasp.

clasp is best understood by looking at Fig. 4. The serrations are continuous from the lower branch to the upper branch, lying across the figure of the clasp. Fig. 3 shows the upper branch folded over so as to conceal the serrations from the lower to the upper branch as they lie behind it. Evans does not fill in details. Folds exist for example in *homolea aucma* and in *arcuata.* Their serrations are actually like those in fig. 4 when viewed from the outside. The figure in Evans of *arcuata* is incorrect. If he had shown the narrow fold of the upper branch, diagonally across the clasp, it would have concealed some of the serrations. As the fold is narrow in *arcuata,* if the clasp is not viewed quite flat but at a slight angle, all of the serration is just visible from the inside as so has been drawn on Evans's figure. But this is incorrect. On the other hand, to take some examples: the figures of *kumara, knyvetti,* and *wantona* showing the complete serrations are correct because the upper branch is not folded over. The interior markings showing the edges of folds or edges of double layers of the cuiller are very hard to figure as one is uncertain whether they should be shown on the outer or inner aspect of the clasp.

I give the name *scissa* to the butterfly because of the deeply cleft uncus. There are variations in depth of cleft in individuals of other species. I have an *arcuata* with a cleft almost as deep.

5, Upper Wimpole Street,
London, W. 1. KEITH CANTLIE
July 15, 1961.

19. MORPHOLOGICAL DIFFERENTIATION OF THE LARVAL INSTARS OF *SIMULIUM ORNATUM* MEIGEN (NEMATOCERA, DIPTERA), WITH A NOTE ON ITS METAMORPHOSIS AND ECOLOGY

(*With a plate*)

The following observations were made on thousands of living specimens in the streams of Priddy and Limpleystoke, Bristol, England, and also on larvae kept alive in large aquaria in the zoology laboratory of the University of Bristol at 14°-16° C., and artificially aerating the water.

It is a very old idea to presume that larvae are precocious embryos. According to Lubbock (1874), the occurrence of metamorphosis arises from the immaturity of the condition in which some animals quit the egg. This may be true in the case of the primary larvae of some parasitic Hymenoptera, which have unsegmented abdomens and undeveloped respiratory and nervous systems on hatching. This is not true, however, of all insect larvae, particularly of the *Simulium* larva, because its morphological features and anatomical structures are very well developed, even at the time of emergence from the egg.

The larva of *Simulium ornatum* lives attached to stones or weeds in swift-flowing streams (5-7 ft. = 1.5-2.1 m. per second). Some of the outstanding features possessed by the larva to cope with its aquatic environment are: the specialized mouth brush for collecting food; the sticky salivary secretion, often used for suspension when it is detached; the thoracic proleg and the posterior sucker with hooks, enabling movement and fixation; and anal gills for respiration.

When the larva is detached from its point of attachment, it clings on to a silken thread (salivary secretion) and soon regains its original position. In this endeavour the thoracic proleg and the posterior sucker are of immense help. The posterior sucker is the main organ of attachment. The radiating rows of hooks, about seventy-five in number, strongly grip the sticky salivary secretion which fills up the spaces between the hooks, forming a complete rim all round. The term 'posterior sucker', adopted by many authors, suggests the idea that this organ functions like a true sucker. Helped by the muscles attached to the periphery of the sucker and the centre of the disc, this organ actually works like a sucker, especially at the initial stage of attachment, when the salivary secretion is not sticky enough for the firm fixation of the hooks.

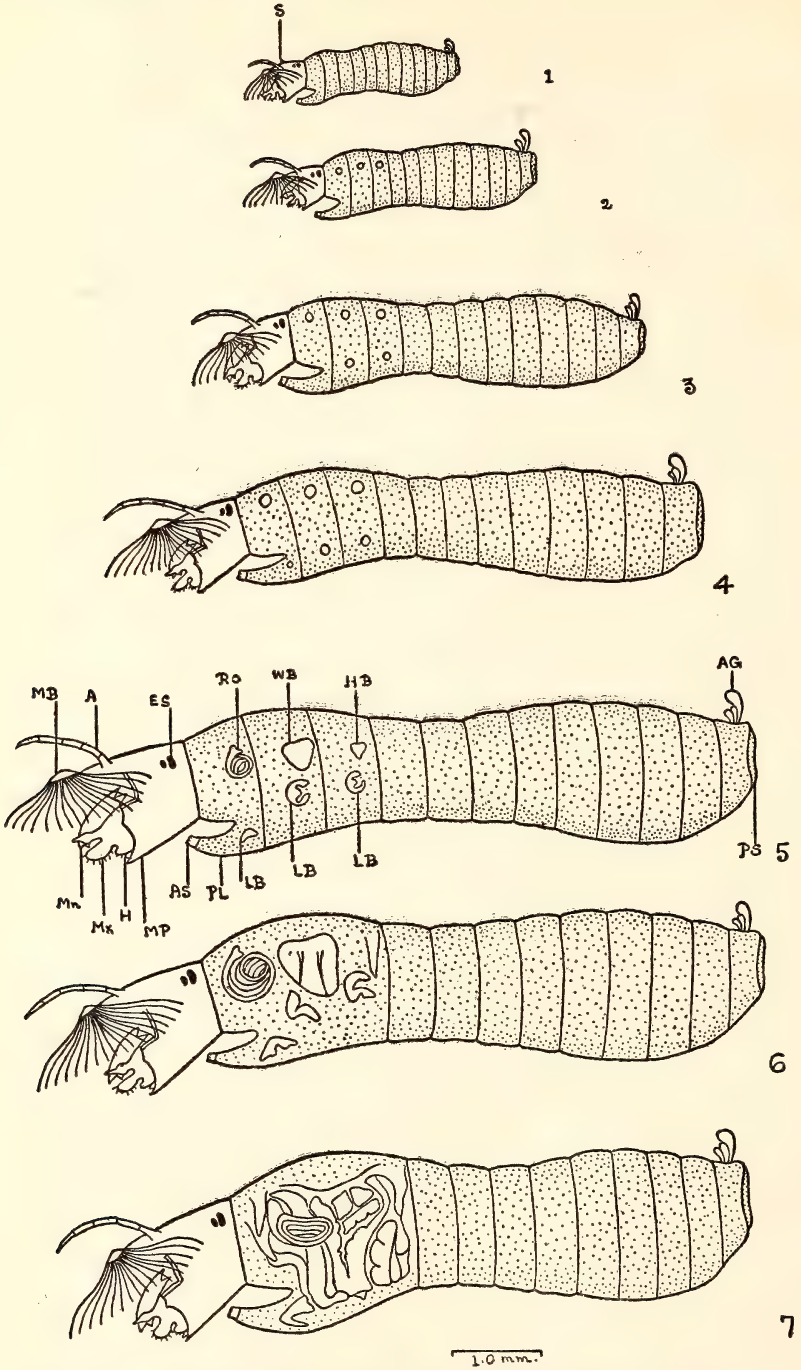


Fig. 1. 72-hour old first instar larva ; Fig 2. 120-hour old second instar larva ; Fig. 3. 96-hour old third instar larva ; Fig. 4. 72-hour old fourth instar larva ; Fig. 5. 120-hour old fifth instar larva ; Fig. 6. 72-hour old sixth instar larva ; Fig. 7. 108-hour old pharate pupa.

A. Antenna, AG. Anal gill, AS. Anterior sucker, ES. Eye spot, H. Hypopharynx, HB. Haltere bud, LB. Leg bud, MB. Mouth brush, MN. Mandible, MP. Mental plate, Mx. Maxilla, PL. Proleg, PS. Posterior sucker, RO. Respiratory organ, S. Spine, WB. Wing bud.

Usually three generations are produced every year, with longer intervals between the various stadia, during the winter.

According to Puri (1925) and Smart (1944) there are three thoracic and eight abdominal segments in *Simulium* larvae. But, actually there are three thoracic and nine abdominal segments, as suggested by Grunberg (1910) and Hermes (1923). This is clearly revealed by the arrangement of the muscles in the larva of *Simulium ornatum* (to be published elsewhere).

During the initial stages of an instar, when the old and new cuticles lie near to each other, the space between them is filled by the exuvial fluid. Later on, when the space between them increases, the moulting fluid is withdrawn and the space is partially filled with air. At this stage the outer cuticle lies around the body as a loose bag and many tonofibrillae connections between the two cuticles become gradually detached. The old cuticle usually stays on for several hours, even after all the tonofibrillae connections between the two cuticles have become completely detached. This often leads to underestimation of the age of the larva. Generally in calculating the duration of each instar, the time spent by the new instar within the cuticle of the previous instar is attributed to the old instar. But, actually the moult has occurred already, though ecdysis has not taken place. As pointed out by Hinton (1958), the detachment and the retraction of the epidermis from the cuticle indicates the real moult.

First instar larva (Fig. 1). The three thoracic and nine abdominal segments, with all the specialized organs are present in this instar. A spine, the egg burster, situated dorso-medianly on the head in between the eyes, is a characteristic organ of this larval instar. It helps the larva to come out of the egg. The imaginal buds are not morphologically evident. The length of the body is about 2 mm. and thickness about 0.5 mm. This instar lasts for five to seven days.

Second instar larva (Fig. 2). The body is cylindrical in shape. Three pairs of small spherical imaginal buds, one pair in each of the thoracic segments, situated dorso-laterally, become morphologically visible. The imaginal buds are not very distinct and conspicuous.

The imaginal bud in the first thoracic segment is destined to give rise to the respiratory filament, that in the second thoracic segment to the wing, and that in the third thoracic segment to the haltere. The body is about 3 mm. long and 0.8 mm. thick. This larval instar lasts from six to eight days.

Third instar larva (Fig. 3). During this stage the contour of the body becomes a little altered. The thorax becomes humped and the abdomen gradually assumes the clubbed shape. Abdominal segments one to three are comparatively smaller than the rest. In addition to the three thoracic imaginal buds of the previous instar, two imaginal buds become evident, situated ventro-laterally in the second and third thoracic segments. These two buds are destined to develop into legs. The length of the larva is about 5 mm. and the thickness is about 1 mm. This larval instar lasts for seven to nine days.

Fourth instar larva (Fig. 4). Another pair of buds appear on the ventro-lateral aspect of the prothorax, near the place where the proleg joins it. This is destined to develop into the prothoracic leg. This is the six-bud stage. No more buds appear, but these six buds gradually expand in size due to the multiplication of cells. The length of the body is about 7.5 mm. and the thickness is about 1.2 mm. This larval instar lasts for six to eight days.

Fifth instar larva (Fig. 5). The larva attains its maximum length at this stage. The humped thorax, club-shaped abdomen, and cylindrical body gives the larva its characteristic graceful contour. The respiratory bud becomes black in colour and shows the developing respiratory organ inside. The wing and the haltere buds have become roughly triangular in shape, with the base of the triangle towards the dorsal aspect of the body. The wing bud is larger than the haltere bud. The leg buds of the meso- and meta-thoracic segments show the developing legs inside. The prothoracic leg bud remains smaller than the other two leg buds. The length of the body is about 9 mm. and the thickness is about 1.5 mm. This larval instar lasts for six to eight days.

Sixth instar larva (Fig. 6). Due to rapid segmentation, all the buds become enlarged and show the characteristic shape of the organ into which they are destined to develop. The superficial lines of demarcation between the three thoracic segments disappear. But the three thoracic segments can be differentiated with the help of their developing imaginal organs. The length of the body is about 9 mm. and the thickness about 1.8 mm. This larval instar lasts for six to eight days.

Pharate pupa (Pre-pupa) (Fig. 7). This is actually the pupa within the larval cuticle. According to Hinton (1946), the term 'pharate' denotes the phase of an instar which is enclosed within the cuticle of the previous instar. The thorax becomes much more humped and the abdomen highly club-shaped. The body becomes shorter and thicker. Dissections of this stage show that the mesothorax becomes much enlarged, providing more space for the accommodation of the rapidly differentiating indirect flight muscles. The imaginal buds have spread out in such a way that the three thoracic segments become indistinguishable externally. The respiratory organ remains conspicuous. Body of this instar is about 8 mm. long and 2 mm. thick. This instar lasts for four to six days.

The termination of the larval stage and the onset of the pupal phase necessitates the modification, replacement, or reconstruction of some larval organs and tissues. This is because the aquatic larva has organs to suit its immediate requirements and the transformation of most of the organs becomes inevitable, since the adult has to live in a different environment altogether. This requires a good deal of internal change consisting of tissue destruction or histolysis, and tissue rebuilding or histogenesis, along with external morphological changes.

In *Simulium ornatum* the cocoon is spun by the pharate pupa and not by the larva. The pharate pupa is active. At this stage the larval muscles and imaginal muscles exist side by side, because the larval muscles are necessary to spin the cocoon. After the cocoon is spun the larval muscles have no significant function to perform and hence they become histolysed. The pharate pupa becomes inactive after the larval cuticle is shed. Subsequently the body is reconstructed and remoulded resulting in the imago.

Large-scale biological observations on *Simulium ornatum* Meigen are not possible in India owing to the paucity of its occurrence. It is profusely present in many localities in the United Kingdom owing to the favourable cold climate.

Department of Zoology,
Scott Christian College, V. J. I. GRANT
Nagercoil,
April 12, 1961.

[*Simulium ornatum* is a Palaearctic species but allied forms occur in India, one of them, *S. indicum*, being a troublesome pest in parts of the Himalayas.—Eds.]

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20. A NEW SPECIES OF THE GENUS *CALLANTRA* WALKER FROM INDIA (DIPTERA: TRYPETIDAE)

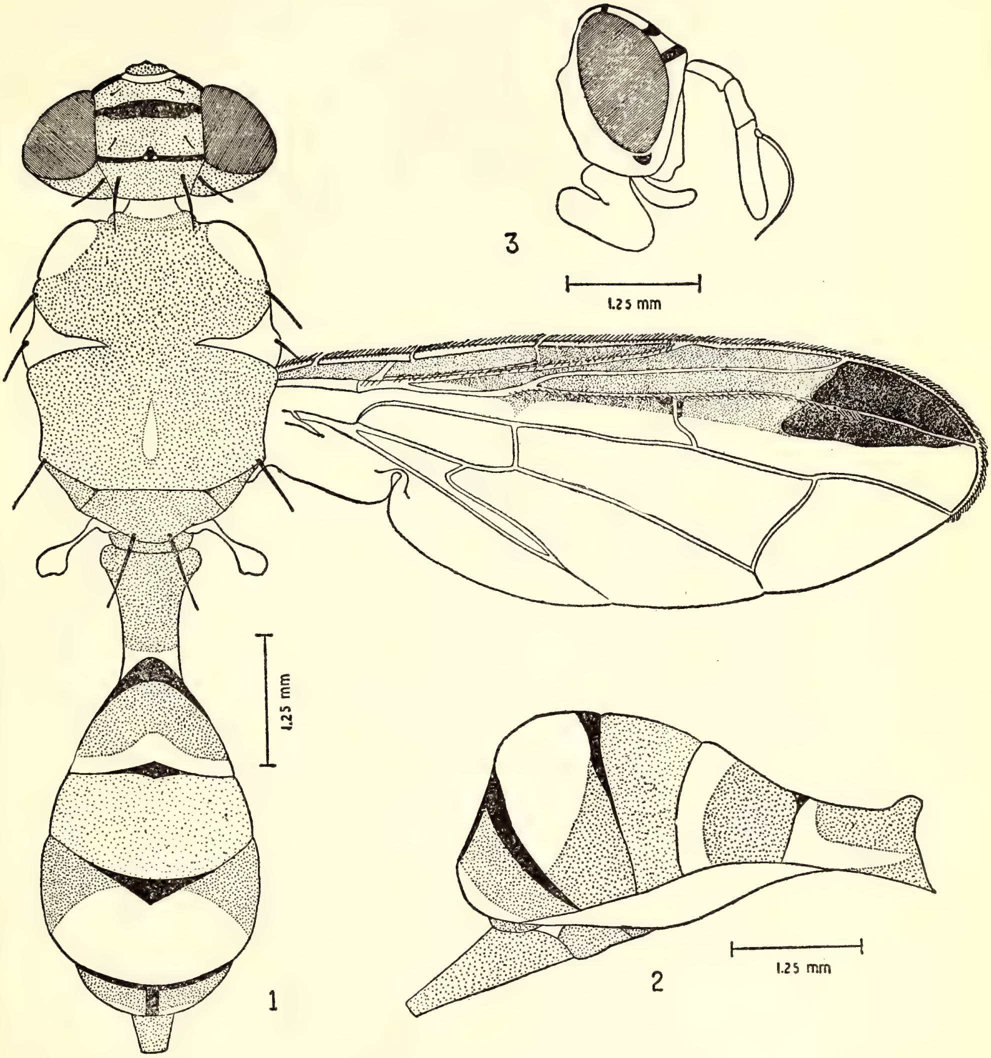
(*With a plate*)

The genus *Callantra* was first proposed by Walker in 1860 with a new species *Callantra smieroides* designated as the type. Genus *Mellesis* Bezzi with *Mellesis crabroniformis* as the genotype was transferred to *Callantra* by Hendel (1927). Malloch (1939) considered *Callantra* as a sub-genus of *Dacus* Fabricius; this is not accepted by recent taxonomists.

Callantra munroi sp. nov.

Female. General coloration of the body pale red; length of body (excluding the oviscape) 1.0 cm.; wing 6.89 mm. long, 2.55 mm. broad, 2.7 times as long as broad; entire body covered with very fine white hairs.

Head. 1.09 mm. long, 2.31 mm. wide, 1.69 mm. high; frons flattened, 0.37 mm. long, 1.04 mm. wide, 0.44 times as long as the maximum width of either eye; colour of the frons yellowish red, darker than the face; ocellar triangle black; face lighter in shade than frons, 0.86 mm. long; face with a black, transverse band along the epistomal margin, its ends slightly curving upwards; a black spot on each gena slightly below the eye; lunule light black; a black rectangular spot on either side of the top of the ptilinal fissure at the level of lunule; a complete transverse band in the middle of frons connecting the eyes; a black spot on either side of the ocellar triangle connecting the latter with the corresponding eye margin; each eye


3
1.25 mm
1.25 mm
1
1.25 mm
2

Callantra munroi sp. nov.

Fig. 1. Adult female; 2. Abdomen, lateral view; 3. Head, lateral view

1.4 mm. high, 0.84 mm. wide; first antennal segment 0.42 mm. long, 0.13 mm. wide in the middle, 0.48 times as long as the face; second antennal segment 0.42 mm. long, 0.17 mm. wide in the middle; third antennal segment 0.9 mm. long, 0.19 mm. wide in the middle; first, second and third antennal segments 3.23, 2.47, and 4.7 times as long as wide, respectively; posterior surface of the head dirty yellow, gulomental region a little darker; lower orbital one, black; upper orbital one, black; inner verticals brownish yellow; outer verticals brownish yellow; ocellars black; postorbitals (occipital row) approximately six, all brownish yellow; genal one, black; a few small black hairs surrounding the inner verticals at base.

Thorax. Thorax yellowish red, covered over with tiny white hairs; the following regions are yellow: humeral calli (slightly tinged with red along postero-dorsal margin), sutural calli, a border along the anterior margin of the suture laterally expanding to merge with the yellow sutural callus on either side, a faint stripe in the middle of scutum behind the suture sharply tapering anteriorly and rounded posteriorly, the scutellum (basal margin narrowly tinged with red), a large spot on the lateral plate of postscutellum, posterior half of mesopleura, postero-dorsal region of sternopleura below the mesopleural yellow band, upper region of the hypopleura; all coxae concolorous with thorax; fore legs much shorter than others; fore femora entirely red, proximal ends of mid and hind femora pale white; fore femora with three stout black bristles beneath, and a longitudinal row of five pale bristles on the dorsal side; all tarsi, except the terminal ones, pale white; the terminal tarsi yellowish red; mid tibiae with a stout black terminal spur flanked on either side by a brownish yellow spine close to it, and two yellow smaller spines situated slightly away; notopleurals two, brownish yellow; posterior supra-alars (anterior pair) brownish yellow; scutellars one pair (apical pair), brownish yellow; mesopleural one, black and weak; pteropleural one, very thin and pale red, discernible with difficulty; scutellum 0.71 mm. long, 1.36 mm. wide, 0.52 times as long as wide; wings with first and second veins bristly; a broad costal band which is light brown in colour and includes the costal cells, stigma, marginal and sub-marginal cells, the anterior half of the first posterior cell, and the anterior margin of the first basal cell; the apical spot of the costal border fuscous and roughly triangular in shape (the base lying between the ends of second and third veins, and the apex extending into the first posterior cell); a small fuscous triangular spot along the upper portion of the anterior cross-vein; stigma smoky yellow; base of the anal cell extension slightly narrowed; anal cell extension 0.83 times as long as the second basal cell; anterior cross-vein 2.2 times its length away from the posterior cross-vein; anterior cross-vein sinuate; first vein ending above the anterior cross-vein; halteres pale white.

Abdomen. Distinctly petiolate and clavate; yellowish red in colour and covered over with abundant white hairs which are comparatively longer on the sternites; except these white hairs there are no other bristles on the abdomen; length of abdomen (excluding the oviscape) 4.38 mm., width 2.07 mm.; first segment 1.09 mm. long, 0.94 mm. wide at base, 0.52 mm. wide at apex, 2.09 times as long as its width at the apex; abdomen highly arched up in lateral view; second, third, fourth, and fifth segments approximately 1.5, 2.8, 3.1, and 1.9 times as high as the first segment, respectively (all heights taken in the middle of the segments concerned); junction of third and fourth terga only moderately concave; oviscape in lateral view 1.5 mm. long, 0.82 mm. high at base, and 0.17 mm. high at apex, tubular in shape; first abdominal tergum yellowish red, pale white posteriorly; second tergum with a narrow black border along its anterior margin getting broadened in the middle, a pale white border along the posterior margin slightly arched anteriorly in the middle of the tergum, rest of the tergum yellowish red; third tergum uniformly yellowish red, darkest in shade, median part of its anterior margin tinged with black; fourth tergum with a black border along its anterior margin which gets broadened in the middle, a large pale spot (faintly tinged with red) occupies a great part of the tergum in the middle and extends up to the posterior margin restricting the yellowish red ground colour of the tergum to the lateral sides; fifth tergum strongly slopes down, with a black border along its anterior margin and a black mid-longitudinal stripe traversing the entire length of the tergum, the latter stripe unites with the former to form a T-shaped black pattern, posterior margin of the fifth tergum pale (faintly tinged with red); sixth tergum very small, completely concealed by the fifth; first sternite yellowish red, the subsequent sternites getting progressively darker in shade; the membrane intervening between the terga and sterna pale white

Male. Unknown.

Holotype: A single female in personal collection (ZR 2), taken at light, 7-9-1958. The holotype will be deposited in the Zoology Museum, Muslim University, Aligarh.

Host: Unknown.

Locality: University Campus, Aligarh, India.

DISCUSSION

The present species differs from:

1. *Callantra polistiformis* (Senior-White) in having the central transverse band of the frons complete, the presence of the ocellars, one pair of upper orbitals, one pair of lower orbitals (two pairs in *C. polistiformis*), presence of anterior notopleurals, only one pair of posterior supra-alars (postalars), and the distinctly defined different abdominal markings.

2. *Callantra destillatoria* (Bezzi) in having the bristles brownish yellow instead of black, the absence of scapulars and the anterior supra-alars, and the different abdominal markings.

3. *Callantra eumenoides* (Bezzi) in having a complete central transverse band on the frons, the presence of one pair of lower orbitals, and the tubular oviscape which is uniformly coloured.

4. *Callantra crabroniformis* (Bezzi) in having the fore femora spined beneath, the yellowish red coloration of the body, and the different pattern of the abdominal markings. Moreover, the bristles are brownish yellow and not black as in *C. crabroniformis*.

5. *Callantra icariiformis* Enderlein in having a complete black border along the ventral margin of the face, the proximally pale hind femora. The yellowish red underside of the first abdominal segment, and the different pattern of the abdominal markings.

The species is named after Dr. H. K. Munro, Division of Entomology, Department of Agriculture, Pretoria, South Africa, a well-known authority on Trypetidae, in token of the high regard which the present writer has for him.

ACKNOWLEDGEMENTS

The present writer feels privileged to acknowledge his grateful thanks to Dr. S. M. Alam, in-charge Entomology Section, and Prof. M. A. Basir Khan, Head of the Zoology Department, for the provision of research facilities.

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July 14, 1961.

MD. ZAKA-UR-RAB

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21. A COMMENT ON THE RECORD OF *KHAYA SENEGALENSIS* A. JUSS. FROM PONDICHERRY[1]

Dr. K. A. Shankarnarayan's claim (Shankarnarayan, 1959) that *Khaya senegalensis* A. Juss. is a new plant record from Pondicherry calls for comment.

It is reported by Dr. Shankarnarayan (1959) and Viart (1960) that the plant was introduced in the Empress Garden at Poona and in the Botanical Garden at Pondicherry. The seeds for Poona were obtained from Uganda in 1941; but the source of the seed for Pondicherry is not known.

Khaya senegalensis A. Juss. occurs naturally under two types of African climate—(i) the Sudano-Guinean climate, and (ii) the Sahalo-Sudanese climate, and so far I am aware, the plant has not been reported to be growing wild anywhere in India.

A plant is said to be a new record for a country when it is indigenous to that country, but has not been reported earlier; alternatively, as Rev. Fr. H. Santapau has pointed out in a personal communication, a plant is a new record for a country when it was brought into that country as a garden plant but escaped from the garden and established itself freely in waste lands. This is the case with plants of the genus *Cosmos*, which are garden plants but have now been observed widely spread on the hills between Jeypore in Orissa and Anantagiri in Andhra. It also happens sometimes that a plant introduced in a country escapes and naturalises itself in the neighbouring country. For instance *Lantana camara* Linn. a native of tropical America was introduced into Ceylon and is now naturalised in India. Similar, though not identical, are the cases with

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[1] Communicated by the Regional Research Laboratory, Jammu.

Gomphrena celosioides Mart., *Eichhornia crassipes* Solms., *Martynia diandra* Glox., etc. Apparently *Khaya senegalensis* A. Juss. does not come under any of these categories and the claim of Dr. Shankarnarayan needs modification. However, he deserves thanks for giving us the morphological description of the plant and other relevant information relating to the introduction into our country of a plant, whose wood is reported to be akin to true Mahogany.

Since the record of *Khaya senegalensis* A. Juss. from Indian soil may create subsequent complications, I consider it necessary that the comment be published.

The author is grateful to Dr. L. D. Kapoor for kindly going through the manuscript critically and to Rev. Father H. Santapau, St. Xavier's College, Bombay, for his kind suggestions.

REGIONAL RESEARCH LABORATORY,
CANAL ROAD,
JAMMU,
May 2, 1961.

A. K. DUTT

REFERENCES

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22. *SHOREA TALURA* ROXB., A SYNONYM OF *S. ROXBURGHII* G. DON

In our Indian floras one species of *Sal* goes under the name of *Shorea talura* Roxb. In accordance with the INTERNATIONAL CODE OF BOTANICAL NOMENCLATURE (ed. 1956), this name cannot stand and must be changed to *Shorea roxburghii* Don.

The nomenclature of the plant given in Hooker's FLORA OF BRITISH INDIA (1 : 304, 1874) is the following: *Shorea talura* Roxb. Hort. Beng. 93, 1814, nom. nud. et Fl. Ind. 2 : 618, 1832; *S. laccifera* Heyne ex Wall. Cat. 967, 1829, nom. nud., A. DC. Prodr. 16 (2) : 630, 1868; *S. roxburghii* G. Don, Gen. Syst. 1 : 813, 1831; *S. robusta* Roth, Nov. Pl. Sp. 221, 1821 (non Gaertn. f. Fruct. 3 : 48, t. 186, 1805-1807); *Vatica laccifera* Wt. & Arn. Prodr, 84, 1834, Wight, Icon. t. 164, 1839.

Of these names, *Shorea talura* Roxb. dates from 1814 but the validity only counts from 1832, when the plant was given a description; *S. laccifera* Heyne ex Wall. was only validated by A. De Candolle in 1868; *S. robusta* Roth was described in 1821, but the name is a later homonym of that of Gaertner f. of 1805-07, and therefore invalid in accordance with the CODE. The oldest valid name for this plant, in accordance with the CODE, is *Shorea roxburghii* G. Don.

C.S.I.R., PUBLICATIONS DIVISION,
OLD MILL ROAD,
NEW DELHI 1,
May 25, 1961.

G. KASHYAPA

23. AMENDED DESCRIPTION OF *HYDROCERA TRIFLORA* WT. & ARN.[1]

(*With one plate*)

Since the description of the monotypic Indo-Malayan genus *Hydrocera* as given in FLORAS (1, 2) has been found to be inadequate and incorrect in certain respects, it was felt desirable to revise its description to include certain features so far either unrecorded or incorrectly described. For instance, extrafloral nectaries occur on the leaf bases and this is not recorded in the descriptions available so far. The fruit is described as a drupe, but on closer examination it is found to be a capsular berry liberating the seeds.

The genus *Hydrocera* is distinguished from *Impatiens* by the presence of two lateral petals that are free and the fruit which is described as a drupe, whereas in *Impatiens* the lateral petals are united and the fruit is capsular. Since the fruit of *Hydrocera* is now found to be capsular the differences between this genus and *Impatiens* become narrowed. However, the freedom of two lateral petals and the distinctive aquatic habit may still serve to distinguish the monotypic *Hydrocera* from the large genus *Impatiens*.

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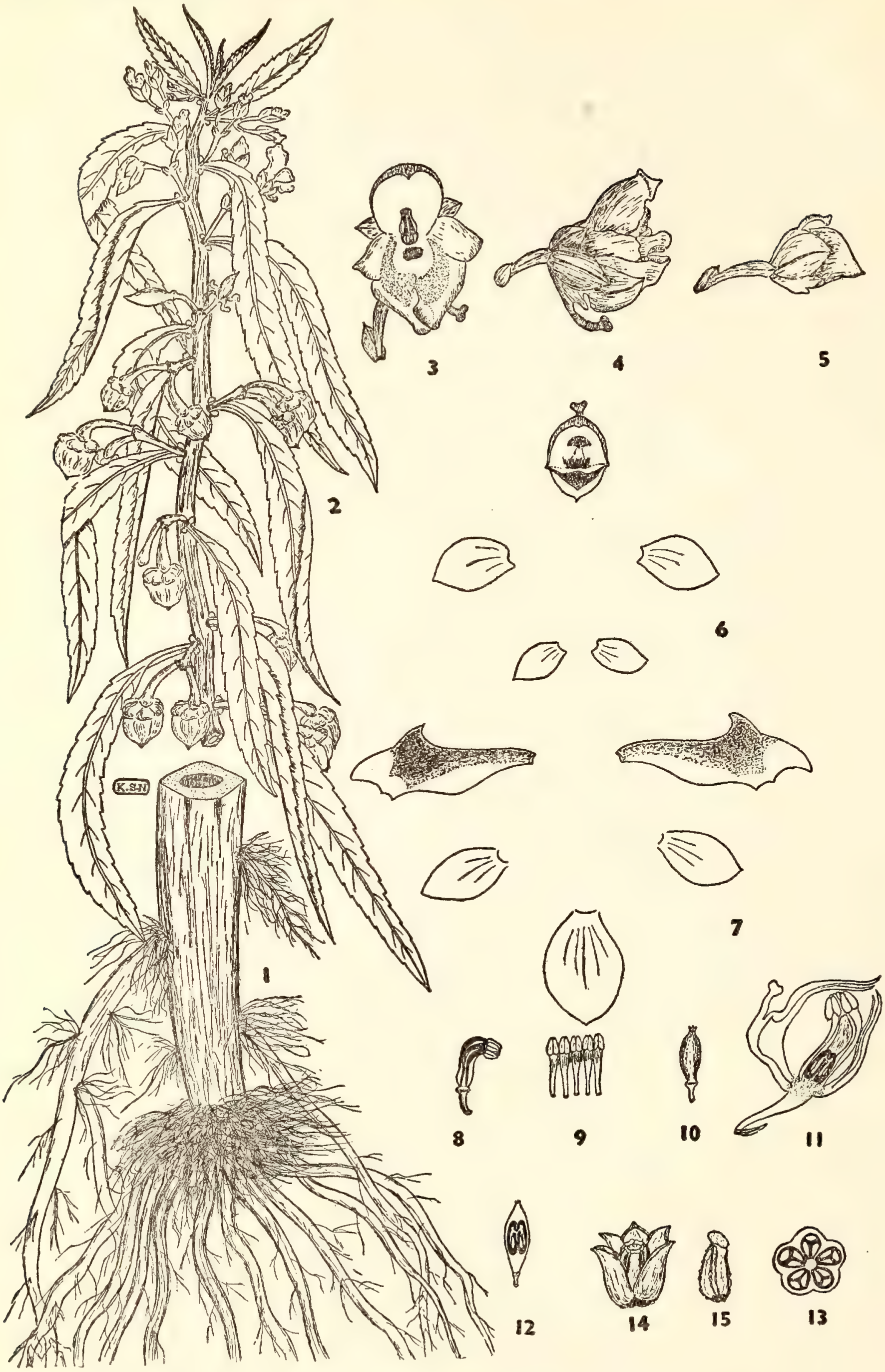
[1] Communicated by Rev. Fr. H. Santapau, S.J.



Hydrocera triflora Wt. & Arn. emend. Venkat. & Dutt

1. Basal part of the stem showing fibrous roots; 2. A twig (note the extrafloral nectaries on the leaf bases); 3, 4. Flower in front and side view; 5. A flower bud in side view; 6. Sepals; 7. Petals; 8. Essential organs; 9. Stamens; 10. Gynoecium; 11. L. S. flower; 12. L. S. Gynoecium; 13. T. S. ovary; 14. Fruit (note the dehiscence); 15. Seed.

Figures 1 & 2 × 0.44.
Figures 3 to 12, 14 & 15 × 0.88.
Figure 13 × 2.64.

DESCRIPTION

Hydrocera triflora Wt. & Arn. emend. Venkat. & Dutt

Herba aquatica profuse ramosa, radicibus longis fibrosisque ornata, altitudinem attingens c. 1 m. *Culmis* pentangularis et cavus in spatiis internodalibus diametiens c. 2.4 cm. ad punctum 20 cm. supra solum. *Folia* alterna, linearia, 11.7×1.5 cm., sessilia, glandularia ad basim, serrata ad margines. *Inflorescentia* axillaris, cymosa, constans floribus tribus, quorum unus vulgo abortivus, caeteri vero bene evoluti sunt. *Flores* bracteati, zygomorphi; *sepala* 5, petaloidea et imbricata, quorum posterius calcaratum et vexillare evadit anterius in flore aperto ob resupinationem. *Petala* 5, libera, quorum bina posteriora longiora, colorata et alis similia. *Stamina* 5, filamentis brevioribus gynoecio sed supra evadentibus latioribus, antheris connatis. *Gynoecium* 5-loculare, ad calcaris latus inclinatum, ovulis ternis in singulis loculis placentae axiali insidentibus; stigmata quina, sessilia, perdurantia in fructu. *Fructus* purpureo-ruber, ad basim truncatus, rostro brevi et curvato ornatus constante stigmatibus perdurantibus; bacca capsularis dehiscit septicide, seminibus remanentibus columnae axiali fixis sed postea liberis. *Semina* vulgo solitaria in singulis loculis, curvata et rugosa, exalbuminata; cotyledones crassi, radicula brevi.

Profusely branched aquatic herb with long fibrous roots and reaching a height of about a metre. Stem five-angular and hollow in inter-nodal region and measuring about 2.4 cm. in diameter at a height of about 20 cm. above soil level. Leaves alternate, linear, measuring 11.7 cm. by 1.5 cm. Petiole 0; leaf base glandular, leaf margin serrate. Inflorescence axillary, cymose with two well-developed flowers and the third usually suppressed. Flower bracteate and zygomorphic; sepals 5, petaloid and imbricate. The posterior sepal spurred and vexillar becoming anterior in open flower due to resupination. Petals 5, free, the two posterior longer, coloured and alae-like. Stamens 5, filaments slightly shorter than the gynoecium and becoming broader and united towards the connective; anthers connate. Gynoecium 5-carpellary superior, bent towards the spur side; ovary 5-locular with three ovules in each loculus borne on axile placentae. Stigmas 5, sessile and persisting in fruit. Fruit purplish red, truncate at base and with a short bent beak of persisting stigmas; capsular berry dehiscing septicidally leaving the seeds attached to the column but separating later. Seeds usually solitary in each cell, curved and corrugated, albumin 0; cotyledons thick, radicle short. (See Plate, Figs. 1 to 15.)

ACKNOWLEDGEMENTS

We are grateful to Rev. Fr. H. Santapau, S.J., for providing the Latin description and for suggestions in the preparation of this paper. We are thankful to Mr. K. Satyanandam, M.SC., for the drawings.

BOTANY DEPARTMENT,
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WALTAIR,
July 7, 1961.

J. VENKATESWARLU
B. S. M. DUTT

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24. *BOSWELLIA OVALIFOLIOLATA* SP. NOV.: A NEW SPECIES OF *BOSWELLIA* FROM SOUTH INDIA[1]

(*With two plates*)

Boswellia ovalifoliolata *Bal.* et *Henry* sp. nov., affinis *B. glabrae* Roxb., a qua tamen differt eo quod sit penitus glabra, eiusque foliola sint ovata, oblonga, obtusa retusaque ad apicem, rotundata ad basim, marginibus integris vel paulum undulatis, paniculae profusius furcatae, sepala et petala glabra.

Arbor decidua 7-10 m. alta, cortice papyraceo, cinereo, decorticante in frustula tenuia. *Folia* 9-25 cm. longa, alterna, stipata ad apices ramorum, imparipinnata, exstipulata; foliola opposita vel alterna, sessilia, 9-13 numero, 1.6-7.4×1.0-5.2 cm., ovato-oblonga, inaequalia et rotundata ad basim, obtusa et retusa ad apicem, integra ad margines vel paulum undulata, glabra, glauca infra, nervis rubescentibus. *Flores* in paniculas magnas axillares dispositi; paniculae foliis vulgo longiores, 5-32 cm. longae; pedicelli 4-6 mm. longi. *Calyx* 5-dentatus, lobis brevibus late triangularibus, persistentibus, glabris. *Petala* 5, distincta, imbricata, glabra, angusta ad basim, obovata, oblonga, 4-5 mm. longa, 2.5-3.0 mm. lata, decidua. *Discus* annularis, crenatus, carnosus, adnatus calycis tubo. *Stamina* 10, longa brevibus alternantia, extus inserta sub discum; filamenta subulata, lata ad basim,

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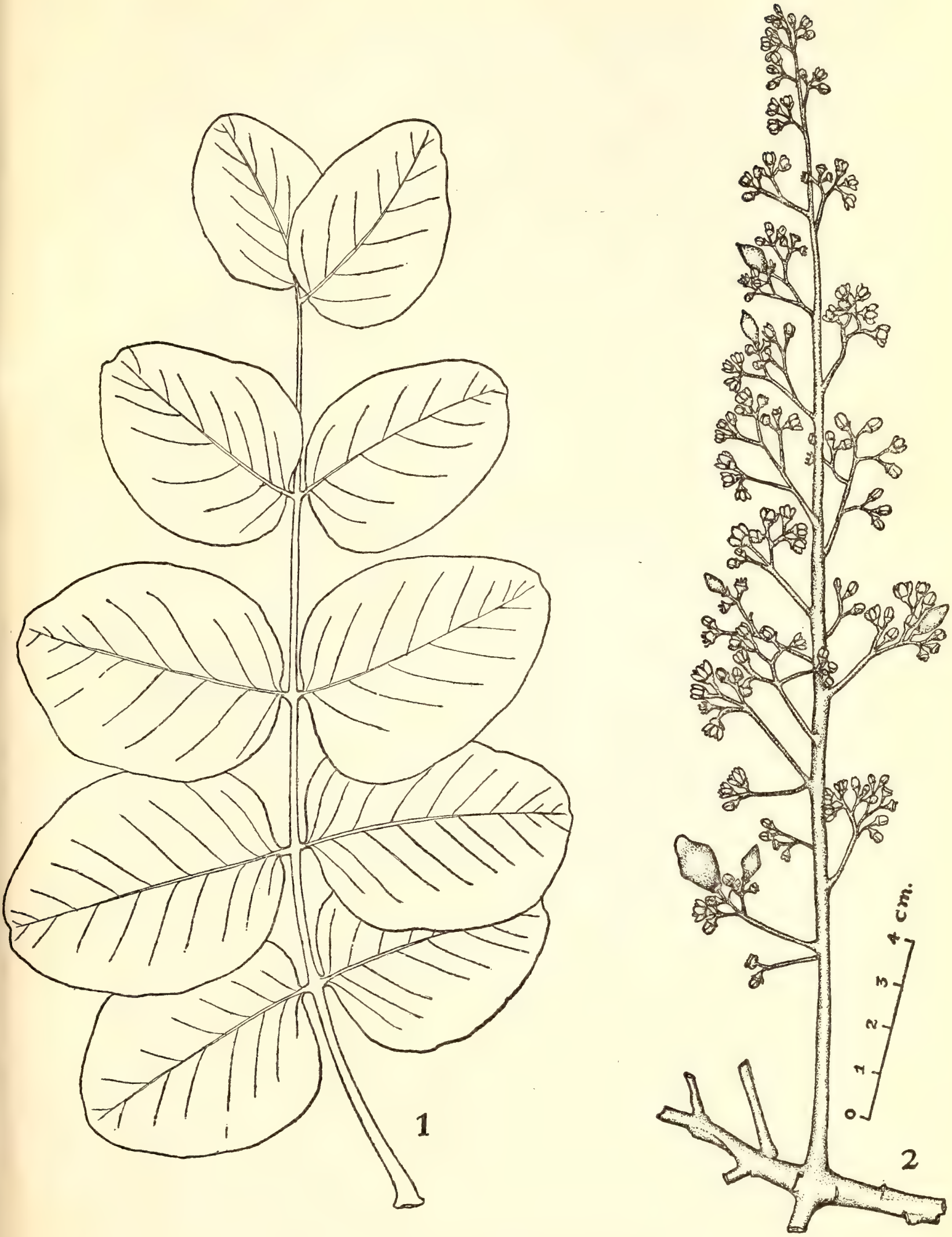
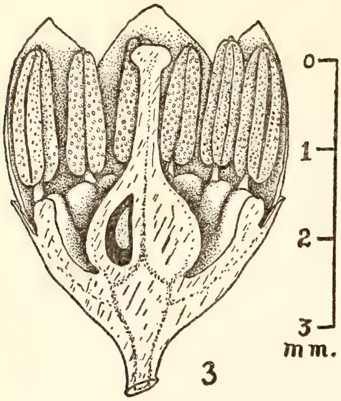
[1] Communicated by Rev. Fr. H. Santapau, S. J.



Boswellia ovalifoliolata sp. nov.

1. Leaf, 2. Inflorescence.



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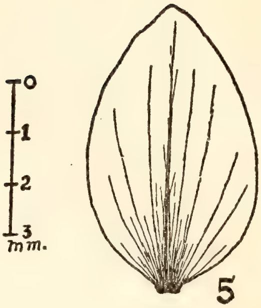

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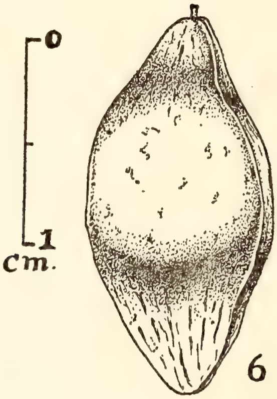

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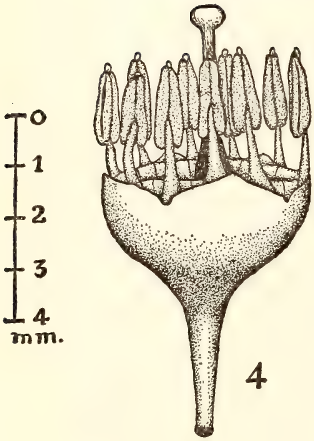

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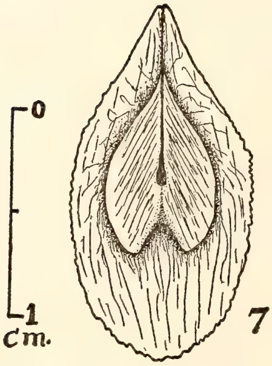

7

Boswellia ovalifoliolata sp. nov.

3. l. s. of flower; 4. flower with sepals removed; 5. petal, outer view; 6. fruit; 7. winged pyrene.

± 1 mm. longa; antherae versatiles, dehiscentes longitudinaliter, parietibus tuberculatis. *Ovarium* sessile, 3-cellulare, disco circumdatum; stylus brevis, ± 2.5 mm. longus, quadruplici sulco verticali ornatus; stigma capitatum; ovula bina in singulis cellulis, collateralia, pendula. *Drupa* trigona, 3-pyrena, 1.0-1.5 cm. longa, 5-8 mm. lata, valvulis septicidis; pyrenae osseae, cordatae, ornatae apice longo et ala lata circumdante, tandem dehiscentes ex axi trigono. *Semina* compressa, pendula; testa membranacea.

Typus lectus in collibus Tirupati dictis, in Dist. Chittoor, in regione Andhrica, ad altit. c. 300 m. die tertio mensis martii anni 1959 a cl. *K. Subramanyam* (7836 A-F); holotypus (*K. Subramanyam* 7836 A) positus in herbario regionis australis Bot. Surv. Ind. ad Coimbatore, sub numero accessionis 15373; isotypi positi ibidem sub numeris *K. Subramanyam* 7836 B-F.

Medium-sized *tree*, 7-10 m. tall; bark papery, ash-coloured, peeling off in thin flakes. *Leaves* 9-25 cm. long, alternate, crowded at the ends of branches, imparipinnate, exstipulate; leaflets opposite or alternate, sessile, 9-13 in number, 1.6-7.4 × 1.0-5.2 cm., ovate-oblong, inaequilateral and rounded at base, obtuse and retuse at apex, margin entire or slightly wavy, glabrous, glaucous beneath, veins reddish. *Flowers* in large axillary panicles; panicles longer than leaves, 5-32 cm. long; pedicels 4-6 mm. long. *Calyx* 5-toothed, lobes short, broadly triangular, persistent, glabrous. *Petals* 5, distinct, imbricate, glabrous, narrowed at the base, obovate, oblong, 4-5 mm. long, 2.5-3.0 mm. wide, deciduous. *Disc* annular, crenate, fleshy, adnate to the calyx-tube. *Stamens* 10, alternately long and short, inserted outside under the disc; filaments subulate, base broad, ± 1 mm. long; anthers versatile, longitudinally dehiscing, anther-wall tuberculate. *Ovary* sessile, 3-celled, surrounded by the disc; style short, ± 2.5 mm. long, with four vertical grooves; stigma capitate; ovules 2 in each cell, collateral, pendulous. *Fruit* trigonous drupe containing 3 pyrenes, 1.0-1.5 cm. long, 0.5-0.8 cm. wide, valves septicidal; pyrenes bony, cordate with a long apex surrounded by a broad wing, finally separating from the trigonous axis. *Seeds* compressed, pendulous; testa membranous (Figs. 1-7).

The type of this species was collected in Tirupati Hills, Chittoor district, in Andhra, at an alt. of about 300 m. on the 3rd of March 1959 by *K. Subramanyam* (7836 A-F); the holotype (*K. Subramanyam* 7836 A) has been deposited in the herbarium of the Southern Circle of the Botanical Survey of India at Coimbatore under accession number 15373; isotypes preserved in the same herbarium under the numbers *K. Subramanyam* 7836 B-F.

It may be mentioned here that there is one specimen in Madras Herbarium, under accession number 8776, collected by R. H. Beddome from Nallamalai Hills of Kurnool Dist., Andhra Pradesh, which perfectly matches the present specimen. Gamble has written on Beddome's sheet: 'Not in Br. Mus. This seems to be distinct from *Boswellia glabra* and probably a new species. But the material is insufficient for description. It should be carefully searched for again in the Nallamalai Hills of Kurnool.'

B. ovalifoliolata Bal. & Henry	*B. glabra* Roxb.
1. Leaves 9-25 cm. long, completely glabrous ; leaflets 9-13 per leaf.	1. Leaves 12-42 cm. long, rarely pubescent on nerves ; leaflets 17-27 per leaf.
2. Leaflets ovate-oblong, suborbicular, obtuse or rarely retuse at apex, rounded at base, margins entire.	2. Leaflets elliptic-lanceolate, acute or subacute at apex, margins entire or rarely crenate-serrate or wavy.
3. Panicles up to 31 cm. long, longer than leaves, much branched, peduncles and pedicels glabrous.	3. Panicles up to 20 cm. long, shorter than leaves, very little branched, peduncles and pedicels pubescent.
4. Sepals and petals completely glabrous ; petals smaller, ± 5 × 3 mm., obovate-oblong.	4. Sepals and petals puberulous outside ; petals larger, ± 7 × 4 mm., ovate-oblong.

ACKNOWLEDGEMENTS

We thank the Director, Royal Botanic Gardens, Kew, for his kind help in connection with the comparison of our specimen with the specimens of *Boswellia* in Kew Herbarium. Our thanks are due to Rev. Fr. H. Santapau, S.J., Chief Botanist, Botanical Survey of India, for kindly translating the description into Latin. We are also thankful to Dr. K. Subramanyam, Deputy Chief Botanist, Botanical Survey of India, for having kindly placed the material for our study and for his valuable guidance and encouragement.

BOTANICAL SURVEY OF INDIA,
SOUTHERN CIRCLE,
COIMBATORE,
July 1, 1961.

N. P. BALAKRISHNAN[1]
A. N. HENRY

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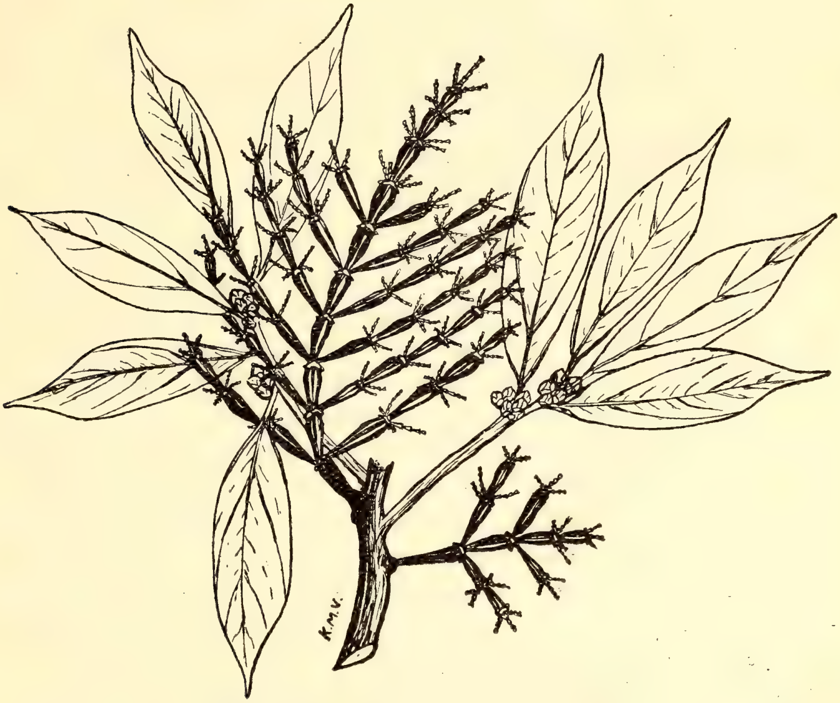
[1] Present address : Botanist, Central National Herbarium, Sibpore.

25. NEW RECORD OF A HOST (*LITSEA UMBROSA* NEES) FOR *KORTHALSELLA OPUNTIA* (THUNB.) MERR.[1]

(*With a text-figure*)

In the NW. and central regions of the Himalayas this tufted, little plant parasite, hitherto known as *Viscum japonicum* Thunb., has been thriving on the various species of *Quercus*. Although the parasite exhibits a preferential partiality towards the Oaks, stray cases of its presence on *Rhus*, *Olea*, *Rhododendron*, *Punica*, and Apricot have also been reported.



Korthalsella opuntia (Thunb.) Merr.

It was a few years ago during a visit to Mussoorie that I chanced to find a couple of plants of this '*banda*' parasite coming up on a small tree of *Litsea umbrosa* Nees. Owing to my close proximity to the place, I kept this particular tree of '*shurur*' (*Litsea*) under close observation and during the course of a couple of years watched the steady spread of the parasite, which had infected almost every branch of this tree. The parasite seems to have developed an adaptability to grow on this new host, as another similar specimen has recently been collected by Dr. M. A. Rau, Regional Botanist, B.S.I., from Garhwal, a place much farther away from Mussoorie.

---

[1] Communicated by Shri M.B. Raizada, Dehra Dun.

Specimen collected on 16-11-1958.

BOTANY BRANCH,
FOREST RESEARCH INSTITUTE,
DEHRA DUN,
March 28, 1961.

K. M. VAID

26. NEW PLANT RECORD FROM BOMBAY : *PHYSALIS LONGIFOLIA* NUTT.

Physalis longifolia Nutt. in *Trans. Amer. Phil. Soc.* **5**: 93, 1837; Dunal in DC. Prodr. 13 (1): 447, 1852.

Perennial herbs, erect, 90-120 cm. tall; stems stout, dichotomously branched, hollow, deeply striate or furrowed, 2-2.5 cm. across near the base, pale green, finely pubescent in younger parts, glabrascent in older. Leaves 2-11.5 × 1.8-6 cm., ovate or oblong-ovate, subentire or irregularly serrate, glabrous above, minutely puberulous beneath; apex acute or shortly acuminate; base cuneate or rounded, decurrent, sometimes oblique; petioles 2.5-7.5 cm. long, glabrous. Flowers solitary, axillary or in the forks of the branches, erect or drooping; peduncles 0.8-2 cm. long, filiform, glabrous or minutely puberulous. Calyx 3-6 mm. long, tubular-campanulate, puberulous outside, divided to about the middle; lobes triangular, short, acuminate; in fruit entire calyx accrescent up to 3 cm. long, purple-veined. Corolla pale to lemon-yellow, with 5 purple or brownish spots on the inside at the base, campanulate, 0.7-1.2 cm. long, limb 0.8-1.5 cm. across. Stamens 5; anthers greenish or greyish blue; filaments 2-3 mm. long, glabrous, yellow. Berries about 1 cm. across, subglobose or somewhat ovate, slightly depressed at the apex, yellow or orange, enclosed in the persistent, accrescent calyx. Seeds auriculate about 1.5 mm. long, yellow, minutely tubercled.

Common, often gregarious by the roadsides and railway lines; occasional in undergrowth on hills.

Flowers and fruits: Nearly all the year.

Specimens examined in the Blatter Herbarium: Khandala, *Santapau* 9614, 11164, 12740; Karjat, *Santapau* 9650; Bombay and Salsette Islands, *Irani* 2027; *V. Patel* 775-761, 963 1247, 1294, 1771; *Shah* 152, 7023, 7036, 8407-08, 8967; *Santapau* 144-10, 5556, 9932, 20948; *Shenoy* 985, 1867, 1938, 4265; Andhra, *SKW* 6973.

World distribution: Native in America; introduced and at present naturalised in the coastal parts of Bombay and Andhra.

Critical notes: In Bombay we have the following species of *Physalis: Ph. peruviana, Ph. minima,* and *Ph. longifolia.* The first is a fairly large shrub, and is found only under cultivation in gardens, where the plant is a favourite of gardeners on account of the 'Chinese Lanterns', that is to say the pendulous, enlarged calyx hanging down from the plant in the manner of a Chinese paper lantern; the plant is cultivated further for the sake of its fruit or berries, which under the name of 'Bombay Gooseberries' are sold in the market, and make excellent tarts etc. The other two species have often been confused, but in general *minima* is much smaller than *longifolia*; they are further distinguished thus:

Corolla uniformly yellow without spots, 5-8 mm. long, the open flowers 4-8 mm. across; anthers yellow ... *minima*
Corolla pale yellow with a few purple or brown spots, 7-12 mm. long, 8-15 mm. across; anthers greenish or greyish blue ... *longifolia*

ST. XAVIER'S COLLEGE,
BOMBAY 1,
June 1, 1961.

H. SANTAPAU, S.J.
G. L. SHAH, M.SC., PH.D.
MRS. Z. KAPADIA, (*née* V. Patel)

27. NEW PLANT RECORD FROM BOMBAY: *ALTERNANTHERA PUNGENS* H.B.K.

Alternanthera pungens H.B.K. Nov. Gen. et Sp. 2 : 206, 1818; Melville in Kew Bull. 13 : 174, 1958. *Alternanthera repens* (L.) Link, Enum. Pl. Hort. Berol. 1 : 154, 1821; Baker in Fl. Males. ser I, 4 (5) : 91 & 594, 1954; Santapau, Fl. Purandh. 112, 1957 (non Gmelin, 1791). *Achyranthes repens* Linn. Sp. Pl. 205, 1753. *Illecebrum pungens* (H.B.K.) Spr. in Syst. Veg. 1 : 820, 1825.

Creeping herbs, rooting at the nodes, with radially spreading branches, often closely appressed to the ground; stems and branches slender, wiry, often rusty-brown, densely appressedly hairy, 10-40 cm. long. Leaves 1.2-3×0.6-2.5 cm., broadly ovate, obovate or almost orbicular, alternate, subopposite or subfascicled, glabrous or thinly hairy above, densely so beneath; apex obtuse, rounded or subacute, minutely apiculate; base rounded, cuneate or tapering, at times somewhat oblique; petioles 5-10 mm. long, slender, pilose; spikes 5-10 mm. across, solitary or 2-3 together, axillary, globose or oblong, shining white, at length pale straw-coloured; bracts spine-tipped; bracteoles hyaline, very acute or acuminate but not spine-tipped, strongly 3-nerved; the median adaxial tepal is rather flat, hyaline, dentate or toothed at the apex; the two lateral inner adaxial tepals are smallest; all tepals bear a pair of small tufts of glochidiate hairs, abaxial and median adaxial tepals at the base, lateral adaxial tepals about the middle. Stamens five, all fertile. Seeds orbicular, reddish brown.

An occasional weed along roadsides and railway lines. Abundant in reclamation in Bombay. The senior author has been watching this weed for many years and has noted its spread in Bombay. He first noted it as rather common in bare wasteland near the bus station at Saswad, Poona Dt. Some three years later the plant was observed in Poona; then again some four or five years ago he collected this weed along the railway line just past Khandala station on the way down the Ghats. It took the plant about two years further to reach Mumbra, 26 miles along the railway line from Bombay. Finally it has reached Bombay Island of late, but at the time of writing this note it is not yet common nor troublesome. The spiny bracts and perianth parts become hard on drying, and may be an unpleasant surprise if trod upon with bare feet. From the way this plant has been spreading in Bombay, it would seem as if it entered India via the South and is gradually spreading northwards in all directions. The junior author found this plant to be common at Broach and Baroda.

Flowers and fruits: August-May.

Illustration: Melville, t. 2.

Specimens examined in the Blatter Herbarium: Nagpur, *Mirashi* 217; Khandala, *Santapau* 15541; Purandhar, *Santapau* 7075, 7274, 11311, 13927; Bombay and Salsette Islands, *Santapau* 3954, 7224, 7353, 9945; *Shah* 7909; Broach, *Shah* 6509; Baroda, *Shah* 530; Andhra, *SKW* 5203, 6123.

World Distribution: Urban in Symb. Ant. 4 : 221, 1905, makes this plant native in the Central American Islands and in the American continent; the senior author, in 1948, studied this plant in Kew Herbarium, London, and to judge from the specimens available in Kew, the plant in 1948 was found all over tropical America, extending westwards to the Azores (Funchal), the Canaries (Tenerife etc.), Cadiz in S. Spain; and Balearic Islands. There were no specimens from the area between Balearic Islands and India in Kew; specimens from India were very rare. At present it is spread all over peninsular India, and recently it was found in Java.

Critical notes: The oldest name for this plant is *Achyranthes repens* Linn. 1753; in the present genus, the name should have been *Alternanthera repens* Link, 1821, which is the name by which the plant is known to some authors in India; this name, however, is preoccupied by *Alternanthera repens* Gmel. 1791, for quite a different plant. The next oldest available name for the Linnean species in the genus *Alternanthera* is *Altern. pungens* H.B.K., 1818.

ST. XAVIER'S COLLEGE,
BOMBAY 1,
June 1, 1961.

H. SANTAPAU, S.J.
G. L. SHAH, M.SC., PH.D.

28. AN INTERESTING CONDITION OF FRUITING IN BANANA[1]

(*With one photograph*)

The stem of the banana plant is a pseudo-stem composed of a collection of leaf stalks densely packed together. In the banana and quite a few other plants the real stem is more or less a massive rhizome that usually remains underground or just reaches the surface.

Flowering scapes appear on the top of the rhizome and normally become elongated so that flowers and fruits emerge among the expanded leaf blades on the upper part of the plants. If due to injury this false stem is damaged, premature emergence of flowers and fruits often occurs.

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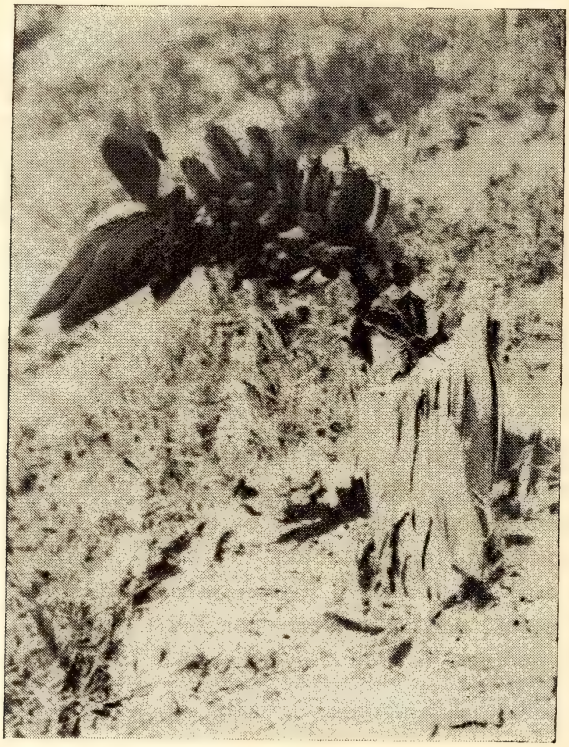
[1] Communicated by the Director, National Botanic Gardens, Lucknow.



Recently some banana plants from a local orchard were transplanted at Banthra nursery of the National Botanic Gardens, Lucknow. After transplanting some plants started drying up at the top. They were cut back to about 45 cm. from the ground level. One of the plants burst into flower and fruit as shown in the above photograph.

NATIONAL BOTANIC GARDENS,
LUCKNOW,
May 26, 1961.

G. S. SRIVASTAVA

29. THE OPHIOGLOSSALES IN NEPAL

The Ophioglossales, due to their primitive position amongst the living ferns, have long attracted the attention of botanists. The three genera, *Ophioglossum*, *Helminthostachys*, and *Botrychium*, are closely related and form a gradual series in complexity of vegetative structures; they have a limited distribution. Thus, the find of a specimen provides material and creates interest in the study of the distribution of the genus or even the species to which it belongs.

The *Botrychia,* also known as the Evergreen Grapeferns, have in recent times received great attention; in America attention is being focused on the distribution, classification, etc., even to the degree of pigmentation amongst the different species. According to Clausen (1944) the classification of the ternate *Botrychia* 'still stands far short of perfection'; they 'are controversial taxonomically' to quote the words of Wagner (1960).

The distribution and taxonomy of the Indian *Ophioglossum* species has been worked out by Chakravarty (1951). Information and data about the representation of this order in Nepal are very incomplete, and the aim of this note is to provide all information that has accumulated so far. Raizada & Vaid (1952), who worked out the collection of ferns made by Fleming from west Nepal, do not mention any member of the order; similarly Alston and Bonner (1956), who have described the sizeable collection of ferns made by Zimmerman of the Swiss Mt. Everest Expedition during 1952 and 1954, make no mention of any *Ophioglossum* species. My explorations of east Nepal over several years have resulted in the collection of some *Ophioglossum* and *Botrychium,* which throw some light on their distribution in Nepal and the Himalayas in general. The different species that are so far known from Nepal are detailed below.

Ophioglossum vulgatum Linn. This species was first reported by Burkill (1910), who collected on the Trisuli banks below Naikot, *c.* 2000 ft. (610 m.). My specimens have been collected in Kathmandu Valley, *c.* 4200 ft. (1280 m.). In east Himalayas, this species is reported from Suriel, 5200 ft. (1520 m.); Goke, 4000 ft. (1220 m.); Rungeet, (no altitude given); south of Sinchul, 7500 ft. (2290 m.). The Nepal specimens come from a lower altitude.

Ophioglossum reticulatum Linn. My specimen comes from Kalinchok Ridge *c.* 10,500 ft. (3200 m.). This was collected in October 1960. There were many immature plants on the grassy slope facing east, but I could collect only three mature specimens. This is a new record for Nepal. There are two specimens of the same gathering deposited in the Nepal Government's herbarium. This species has so far not been reported from east Himalayas. The species is known from Assam, 200 ft. (60 m.); Burma, 6000 ft. (1830 m.); and also Mussoorie 6500 ft. (1980 m.). It may be worth mentioning that I have not been able to find any record of *Ophioglossum* growing at a height of 10,500 ft. (3200 m.). Thus, the present collection records the maximum altitude not only for the species but also for the genus.

Botrychium lunaria (Linn.) Sw. This species has been recorded in west Nepal only by Tagawa (1955) based on specimens collected at Manaslu, *c.* 10,800 ft. (3290 m.). This is the only record for this species.

Botrychium lanuginosum Wall. This species has also been recorded from west Nepal by Tagawa (loc. cit.); he has named the specimens collected at Chokang *c.* 9000 ft. (2740 m.) as *Osmundopteris lanuginosa* (Wall.) Nishida[1]. I have collected this species from two different localities in east Nepal. The first gathering was made in September 1956 above Makaibari on way from Charikot to Kalinchok at *c.* 8000 ft. (2440 m.). There were very few specimens growing in shade and all plants were fully mature. The second collection was made in October 1960 at Sanga Soti *c.* 7500 ft. (2290 m.). Plants were at different stages of growth and maturity.

Botrychium ternatum (Thunb.) Sw.[2] This species is being reported for the first time from Nepal. Specimens collected are from the same locality as for *B. lanuginosum* Wall., i.e. Sanga Soti *c.* 7500 ft. (2290 m.). There were very few plants growing and only two were fully mature, and these were pressed. These Nepal specimens are much more robust than the specimens housed in the Calcutta and Dehra Dun herbaria. This species is also reported from Mussoorie.

ACKNOWLEDGEMENTS

Thanks are due to the University Grants Commission for the travel grant given to me to work out the ferns and fern allies collected in east Nepal. I am indebted to Prof. V. Puri for his suggestions and helpful consultations.

MEERUT COLLEGE,
MEERUT,
March 23, 1961.

M. L. BANERJI

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[1] The genus *Osmundopteris* has recently been changed to *Japano-Botrychium* by Nishida (See *Amer. Fern Journ.* **50** : 128, 1960).

[2] According to Nishida, *Scepteridium ternatum* (Thunb.) Lyon var. *ternatum* Nishida syn. *Botrychium ternatum* Sw. (See *Amer. Fern Journ.* **50**: 131, 1960).

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Notes and News

The XVIth International Horticultural Congress will be held under the sponsorship of the Belgian Government in Brussels from 31st August to 8th September 1962. The Congress secretariat is located at the State Agricultural College, Coupure links, 235, Ghent, whence all further information can be obtained.

* * * *

Vol. III of the late J. L. Peters's CHECK-LIST OF THE BIRDS OF THE WORLD (1937) which has long been out of print has been reprinted. This volume lists the Columbidae and Psittacidae and related families, and is available from the Museum of Comparative Zoology at Harvard College, Cambridge 38, Mass., for $10.

Vol. V ($7), VII ($6), and IX ($7.50) are still available.

With the co-operation of specialists all over the world work is progressing rapidly towards completing the unpublished volumes. Vol. XV, containing the Ploceidae, Sturnidae, Oriolidae, Dicruridae, Paradisaeidae, Corvidae, etc., is in the press, and should be ready early in 1962.

* * * *

Mr. Tom Schnabel, 224 Vance Street, Pacific Palisades, California, U.S.A., is interested in exchanging specimens of American butterflies for Indian varieties. Members interested will please correspond directly with him.

* * * *

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The Breeding Biology of the Forest Wagtail, *Motacilla indica* Gm.[1]

BY

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(*With four plates*)

INTRODUCTION

The Forest Wagtail, *Motacilla indica* Gm., the most peculiar member of the family Motacillidae, is well known in India as a winter visitor but very little has been published about the breeding biology of this interesting bird. During her two expeditions to Amurland the authoress has had a welcome opportunity of studying the Forest Wagtail during its breeding season. The present article, based for the most part on observations made by the authoress, cannot be considered as a detailed monograph as the observations were made simultaneously with numerous other duties.

RANGE

For want of the necessary information the range of the Forest Wagtail cannot be exactly delimited. In the Soviet Union the Forest Wagtail inhabits only the south-eastern part of the country. It is widely distributed in Amurland in the narrow belt of oak forests along the Amur River, extending eastward from Kumara village 51° 36′ N., 126° 41′ E., (see Neufeldt, 1960) to the east of the city of Khabarovsk. In Ussuriland it is known in nearly all the districts of the Ussuri plain and in the Khanka Lake depression; also in the suburbs of Vladivostok (the Muraviev-Amurski peninsula) and Askold Island and, lastly, from the south-eastern foothills of the Sikhote-Alin Range northward to Tetyukhe village (Shulpin, 1931a; Spangenberg, 1949, Vorobiev, 1954). Gizenko (1955) recorded it in the south-eastern part of Sakhalin Island, north of the town of Starodubsk (approximately 47° 25′ N.).

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[1] Communicated by Dr. Sálim Ali.

In the Korean peninsula the Forest Wagtail is distributed in all suitable biotopes (Austin, 1948). In China this bird occurs in the north-eastern provinces (Manchuria) and in the provinces of Hopei (Kansu) and Anhwei (La Touche, 1930; Wilder, 1938). The distribution range shown on the map in Cheng's LIST OF CHINA BIRDS (1958) includes also the provinces located south of the Yangtse River: Chekiang, Kiangsi, and Human, but the authority for this is unknown.

It is not at all certain whether any separate breeding range exists in India. Stuart Baker (1926) includes Assam and adjacent parts of Burma within the range of the Forest Wagtail, because of two nests of the bird received by him from N. Cachar. The authenticity of these two nests is evident from the detailed description published by Stuart Baker (1934), but no more records come from that region. Furthermore, Smythies (1953) pointed out that this species is not to be found in summer in the northern parts of Burma. For this reason I agree with C. Vaurie (1959) in considering these cases of the breeding of this bird as exceptional.

Everywhere within its breeding range the Forest Wagtail is a migratory species, wintering in S. Asia. Only in mild winters it stays the year round in S. Korea (Austin, 1948). In winter it is common in SE. China in the provinces Kwangsi, Kwantung, S. and W. Yunnan, and Hainan Island (Caldwell & Caldwell, 1931). It is recorded as a rather rare bird from the Riu-Kiu Islands (Kuroda, 1933), winters in all the countries of Indo-China, and is well known from the plains of S. Burma (Smythies, 1953) and Thailand (Deignan, 1945). According to Jerdon (1863), Stuart Baker (1926), Sálim Ali (1953) it has been recorded nearly everywhere in Hindustan east of a line drawn from the Sutlej Valley to the Gulf of Cambay. It has been regularly observed in Mysore, Travancore, and Cochin, and along the Malabar coast to the northern extremity of the Western Ghats. More sporadically the Forest Wagtail occurs in other parts of the peninsula. Since it is absent from the Eastern Ghats, Sálim Ali (1953) thinks that the Forest Wagtail probably reaches its winter quarters in SW. India and Ceylon by way of the Andamans[1]. Ceylon is the south-western extremity of the winter range of the species, where the birds were recorded sporadically in many parts of the island. The winter quarters of the Forest Wagtail are known also from the Andamans, the Malay peninsula, and the adjoining islands such as Penang, Singapore, etc. (Robinson, 1927), and from a number of islands of Malaysia, namely Sumatra, Java, Borneo, and others (Legge, 1880; Kuroda, 1933; Delacour, 1947). In N. Philippines, many islands of Japan, and in some provinces of China (Hupeh, Fukien, Szechwan, and N. Yunnan) it is a straggler only (Caldwell, 1931; Delacour, 1946; Anonymous, 1958).

THE SPRING ARRIVAL

The spring movement of the Forest Wagtail from its winter quarters to the breeding range starts in March. The birds leave the Malay peninsula in the middle of March; a little later date has been recorded for their departure from the northern parts of the peninsula (Robinson, 1927). Forest Wagtails leave Ceylon about the end of March (Legge, 1880). The latest spring records of these birds in Burma were made at Martaban Bay on May 1st (Hume & Davison, 1878), and in Thailand near Doi Langka on May 2nd (Deignan, 1945). According to data obtained in different parts of India, Forest Wagtails leave the country in May. And the same can be said of S. China: Kwantung, Kwangsi, W. and S. Yunnan (Caldwell & Caldwell, 1931).

From what has been said above it is evident that the distances between the two seasonal areas are not very great, and the main routes of migration are within the limits of the winter and summer areas of the species.

Forest Wagtails arrive rather late at their breeding places (in the first half of May) and all within a very short space of time. In Nanking (China) Forest Wagtails were recorded in 1944 on 30th April and in 1946 on 3rd May (Hoffman, 1952). In N. China (Hopei) their arrival was noticed at the middle of May (Shaw, 1936), in Peking in 1946 on 22nd May and in 1947 on 18th May (Hoffman, 1952). Among the birds listed by Austin (1948) from Korea the earliest birds were taken in Kyonggi Do province on May 2nd and in the more north-western Pyongan Pukto province on May 9th. In the collection of the Zoological Institute of the Academy of Sciences of the USSR in Leningrad there are the skins of birds collected near Blagoveshchensk (Amurland) on May 12th.

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[1] Recently it has been recorded on passage near Madras in both spring and autumn (Sanjeeva Raj, *J. Bombay nat. Hist. Soc.* **57** : 220 ; **58** : 269).

In a tardy cold spring the arrival can be delayed to the end of May. For instance, in 1945 the first Forest Wagtails were noticed in a region of the Kedrovaya River (Ussuriland) only on 25th May (Vorobiev, 1954). This was also the case in 1959 on the upper Amur; in that year the first small flock of Forest Wagtails was recorded by the authoress near Simonovo village (NW. of Blagoveshchensk) on 26th May. The weather was cloudy with short periods of clear sky and there was a weak north-east wind. The night temperature went down to 3 or 4° C. below zero, and during the day rose to +8° C. or more. On arrival the birds settled on the ground and on trees in a thin Dahurian Birch (*Betula dahurica*) forest which had been burnt that spring. They did not sing but flew from one place to another uttering a very characteristic *ping-teng*. Next day (27th May) the birds were very common in oak forests on the plateau. The arrival of the Forest Wagtails in forests of the upper Amur in 1959 coincided with the time when oaks were covered with young leaves and small fresh leaves began to come out on Dahurian birches. Many birds living in the same biotopes as Forest Wagtails had already arrived and occupied their nest-territories. They were: Spotted Tree Pipits (*Anthus hodgsoni*), Yellowbacked Flycatchers (*Muscicapa narcissina*), Grey Minivets (*Pericrocotus divaricatus*), Needletailed Swifts (*Hirundapus caudacutus*), and Owlets (*Otus sunia*).

During migration Forest Wagtails prefer to keep in forest biotopes of different kinds, but at that period there is much more possibility than at other times to meet them out of forests. On the Amur-Zeya plateau the incoming birds keep in very sparse and light parts of the forests. In particular they readily occupied the parts of forests where recently (approximately one month ago) a forest fire had taken place and where the forest litter and dry twigs were burnt by fire. Just after arrival, Forest Wagtails could be seen in small flocks of 15-20 birds usually in the outskirts of a forest, or near rides and forest roads. They spent nearly all the clear portions of the day on the ground, running in the short spring grass in search of food. On being disturbed they would fly to the lower branches of the trees and there continue their pursuit of insects. The males were extremely animated and sang intensively from 27th May. It seemed that in these noisy flocks females were absent till at least the end of May.

Unfortunately, owing to the absence of sex dimorphism in the coloration of the plumage and the calls of these birds, it was impossible to judge about the sex ratio in the early spring flocks of Forest Wagtails.

BREEDING BIOTOPE

In Amurland the males usually secure their nest-territories by the end of May. As a rule the nest-territory is a part of the territory where the flocks of feeding birds stayed after their arrival from the south. In the region we have explored, only some of the Forest Wagtails were migrants. At the beginning of June the difference between the local birds, which had had nest-territories, and the migrant ones was especially noticeable. In 1959 before 6th June no migrant birds had left. The relations between the local birds and the migrants were absolutely peaceful; so also between the local Forest Wagtails themselves, and between the Forest Wagtails and other small passerine birds breeding near by. No sign of quarrelling was noticed. It was only when man or any large animal intruded into the nest-territory that the male and female raised an alarm. In the upper Amur area, which is nearly the north-western limit of the range, the density of the Forest Wagtail population in suitable biotopes was rather high. For instance, on the narrow strip of the Amur-Zeya plateau covered with oak forests (approximately 3 sq. km.) six pairs of breeding Forest Wagtails were recorded in June 1959, the least distance between the nests noticed being 250-300 m. The territory occupied by each pair was not large; on the contrary the territories were often close to each other or even overlapped. An observer standing near one nest could see one or two other nests and hear simultaneously as many as four singing males. Forest Wagtails are very attached to their territory, which is not only their breeding place but is also the main feeding biotope from the time of pair formation till the nestlings leave their nests.

Forest Wagtails are real forest birds. In the south-western portion of the Amur-Zeya plateau these birds breed mainly in the Mongolian Oak forests, and show a preference for Mongolian Oak with underbrush of Lespedeza or of Lespedeza and Dahurian Rhododendron. Such oak-groves usually occupy flat elevations on the plateau (approximately 280-300 m. above sea-level). This is the north-western limit of the range of the Mongolian Oak, and the trees here are poorly developed. The oldest are only 140-150 years old and are never taller than 25-27 m. More typical of this part of the plateau are trees 10-12 m. in height, with a trunk diameter of 20-25 cm., and a badly-developed crown; most of the branches extend horizontally, the lowest a short distance above the ground. Admixture of other kinds of trees in the oak-groves is insignificant. More common are birches (*Betula dahurica*), larches (*Larix dahurica*), and sometimes pines (*Pinus sylvestris*). The trees stand far from each other, and the forest looks like an orchard. The underbrush comprises mainly low bushes (70-100 cm.) of Lespedeza (*Lespedeza bicolor*). Here and there, thickets of the Dahurian Rhododendron (*Rhododendron dahurica*) of 1-1.5 m. height are common too. Solitary bushes of the hazel (*Corylus heterophylla*) and Dahurian Rose (*Rosa dahurica*) form only an insignificant admixture in the very rich dense undergrowth. Due to plenty of light in such sparse forests the ground is covered with an excellent carpet of herbs, nearly 60 species, for instance *Atractylodes ovata*, *Adenophora latifolia*, *Iris uniflora*, *Vicia pseudorobus*, *Lathyrus humilis*, *Carex nanella*, etc. Bare parts of the ground and near-by bases of oak-trunks are usually covered with mosses.

In undersized Amurland oak-groves Forest Wagtails find very favourable conditions for breeding: the trees stand far from each other, the peculiar structure of the crown of the Mongolian Oak is very convenient for nest construction, the large oak leaves provide the nests with excellent camouflage, there is plenty of building material everywhere, and plenty of insects and other small invertebrata for food. It is necessary to note that only the Grey Minivet (*Pericrocotus divaricatus*), among other small passerine birds living in oak-groves, finds optimal living conditions there. No birds breeding on bushes live in the underbrush of the Mongolian Oak groves. The reason is that the structure of Lespedeza and Dahurian Rhododendron is inconvenient for nest construction. In Amurland near the Simonovo village, besides the birds mentioned above (the Spotted Tree Pipit, Yellowbacked Flycatcher, Grey Minivet, Needle-tailed Swift, Owlet), a few more species were recorded by me in the oak-groves: the Great and Lesser Spotted Woodpeckers (*Dryobates major* and *D. minor*), the Willow Titmouse (*Parus atricapillus*), the Nuthatch (*Sitta europaea*), the Goshawk (*Accipiter gentilis*), and the Siberian Capercaillie (*Tetrao parvirostris*). If we exclude the Goshawk and the Siberian Capercaillie as non-characteristic of such biotope, only ten species of birds can be considered as typical inhabitants of the Forest Wagtail's biotope. In comparison with other types of local forests the upper Amur oak-groves have the poorest population of birds, as regards both number of species and density of population. Many oak trees are rotten inside, and hollow trees are very common. Owing to this the hollow-breeding birds are predominant over other species of birds there.

According to Spangenberg's observations (1940, 1949) at the Iman River in Ussuriland, Forest Wagtails are inhabitants of sparse oak-groves on slanting hill slopes. Shulpin (1931a) considers oak forests with an admixture of birches (*Betula costata* and *B. dahurica*), lime trees (*Tilia amurensis*), and an undergrowth of Lespedeza and hazel bushes as a main biotope in south Ussuriland. Oak groves are also the breeding biotope of this species in Sakhalin Island (Gizenko, 1955).

Such conservatism in the selection of breeding biotopes is the main cause of the unevenness of the distribution of the species within the limits of its breeding range. For instance, large territories along the lower course of the Iman River in Ussuriland are covered with oak forests, and the Forest Wagtails are widely distributed there. Contrary to this these birds occur sporadically along the middle course of the river where there is a spotted distribution of the oak-groves (Spangenberg, 1949). In the upper Amur area the authoress never met Forest Wagtails in small isolated oak groves, though the birds were abundant near by in oak groves occupying large territories.

It is interesting to note that in the territory investigated by the authoress the density of population of Forest Wagtails was rather high, and some pairs lived in Dahurian Birch forests covering terraces in glens. In appearance these Dahurian Birch forests are very similar to oak-groves due to the same construction of the crown of the trees. Like in the oak-groves there is, under the foliage canopy, dense underbrush composed of Lespedeza and hazel bushes, and rich herbage of *Convallaria majalis, Thalictrum minus, Aster scaber, Iris uniflora, Adenophora latifolia, Atractylodes ovata,* etc.

BEHAVIOUR AND SONG[1]

Males sing regularly throughout the breeding period. In 1959 the authoress recorded their songs from 27th May to 10th July. They sang especially intensively before the beginning of nest-building, i.e. from 27th May to 7th June. They were active during daytime, a little more in the morning, less at midday. According to observations made in the environs of Simonovo village on 28th May 1959 males began to sing at five in the morning, and on 5th June at five past four in the morning. They became silent only at sunset, i.e. in June approximately at half past twenty hours. According to Hoffman (1952) in Nanking (China) the Forest Wagtails at the beginning and at the middle of May began to sing approximately at 6 in the morning; on 28th May at 5.40 a.m.; on 1st June they sang with intervals from 5.35 a.m. till 8 p.m.; on 4th June males began to sing at 5.30 a.m., and on 9th June at 5.15 a.m.

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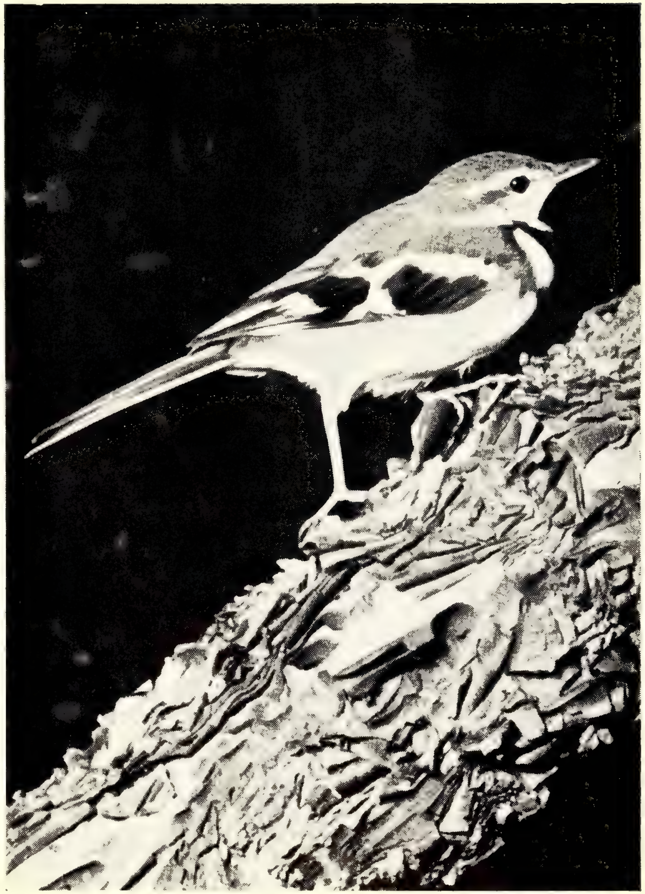
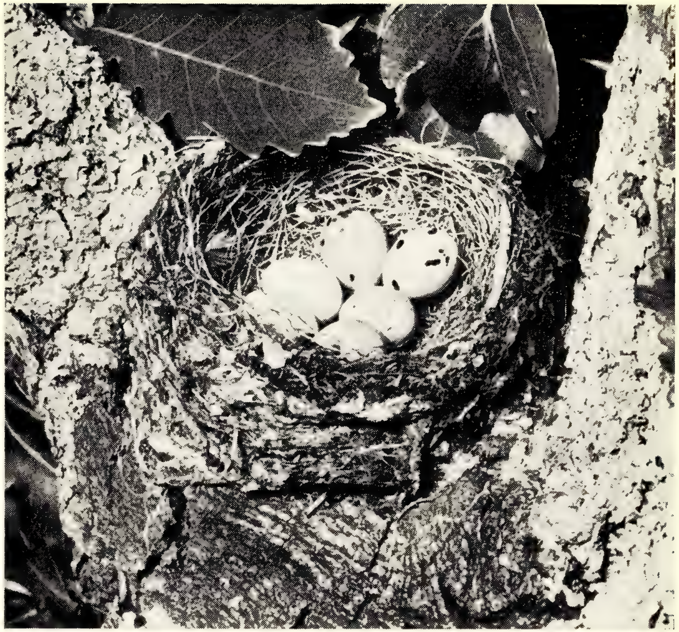
[1] The song of the Forest Wagtail was described in detail by Hoffman (1952).

The song is very simple but rather sonorous, and can be heard from far away. It is somewhat like the song of the Great Tit (*Parus major*), being composed of the disyllabic strophe *tsi-fee*. Usually the male repeats its *tsi-fee* four or five times without a break; sometimes, as if in haste, it includes in its song only two or even only one strophe. The same male may use different variations of the song, usually the long song, very seldom a short one. The male has no favourite place for singing in its breeding territory where it could be seen. Early in the morning at the time of maximal activity some males sing perched on a dead twig at the very top of a high tree (usually birch or aspen). The rest of the time they usually keep at a moderate height in the crowns of oaks or Dahurian Birches. At the period of highest excitement males do not cease singing even while they fly from one tree to another. The authoress has not seen any song-flight in the Forest Wagtails. In spring, at the end of May, males in migrant flocks sang intensively while running on the ground in search of insects. At intervals between songs males emit a call *clink, clink*. Both males and females utter this call as an alarm when frightened and also as a signal to the others when beginning a flight. Many ornithologists who have had the opportunity to observe Forest Wagtails either in the breeding season or in their winter quarters compare this call with the well-known call of the Chaffinch: *chwink, chwink*. In Sálim Ali's (1953) opinion this call of the Forest Wagtail resembles very much the call of the Crested Bunting (*Melophus lathami*). When very much alarmed, Forest Wagtails utter another, more prolonged call: *tsee-fee-ten*.

With the beginning of nest-building (in the south-western portion of the Amur-Zeya plateau after 7th June in 1959) the intensity of males' songs markedly diminished. They could be heard all day, but at long intervals especially towards evening. Males continued to sing near their nests after the full clutches were completed and even

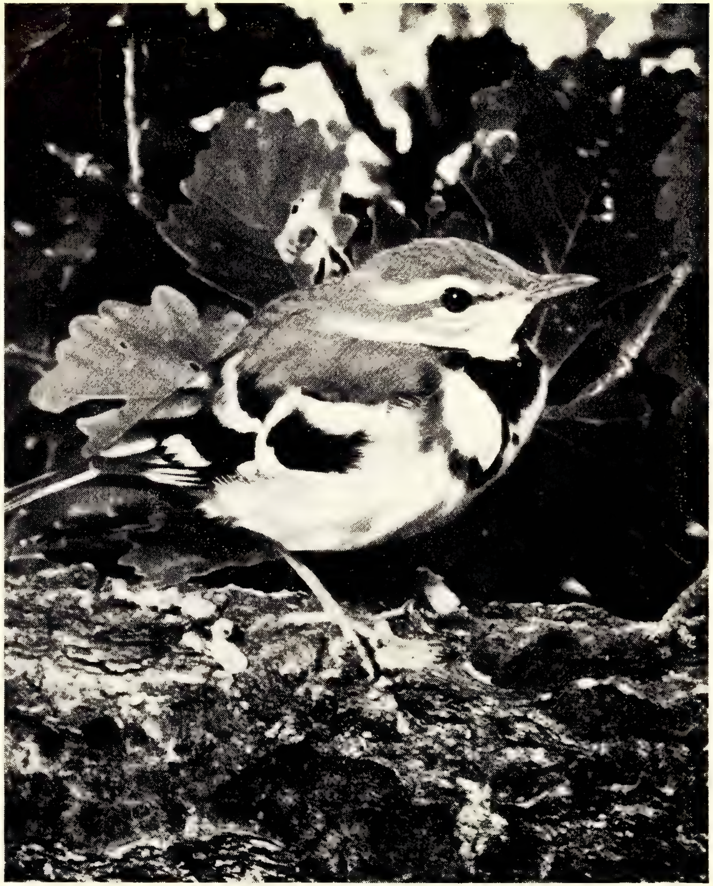


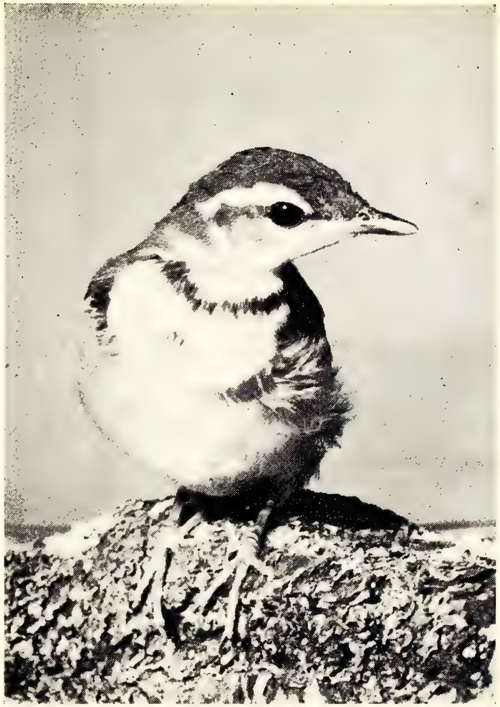


Above. Nest of Forest Wagtail *(Motacilla indica)* in oak tree

Left. Forest Wagtail *(Motacilla indica)* running along inclined branch of Dahurian Birch

(*Photos : Irene Neufeldt*)





Above. Two–weeks–old nestling of Forest Wagtail *(Motacilla indica)*

Left. Forest Wagtail *(Motacilla indica)* at rest

(*Photos : Irene Neufeldt*)

when the nestlings hatched out, but very irregularly. Singing ceased with the end of the nestling period.

Among mimicking birds in Amurland, the Brown Shrike (*Lanius cristatus confusus*) very often and very well reproduces the Forest Wagtail's calls and song. Several times in 1959 the authoress heard a male Brown Shrike which included in its own song phrases adopted from seven species of birds: the Spotted Tree Pipit (*Anthus hodgsoni*), Whitethroated Rock Thrush (*Monticola gularis*), Blacktailed Hawfinch (*Eophona migratoria*), Radde's Bush Warbler (*Phylloscopus schwarzi*), Wryneck (*Jynx torquilla*), Indian Cuckoo (*Cuculus micropterus*) and, distinctly and loudly, the Forest Wagtail.

The singing male, whether running or standing in one place, sways as if in time with its song. To every syllable of the song corresponds the inclination of the bird's body, to one side or the other. Such lateral pivoting of the body is also habitual with females, and even with young birds recently fledged. This peculiarity was the reason of the Japan name of the bird, *Jokofury-sekirei*, i.e. Sideways-swinging Wagtail (Austin, 1948). Unlike other wagtails and pipits the Forest Wagtails never swing their tails in the same way[1].

The Forest Wagtail is the only member of the large family Motacillidae which builds its nest in trees. At the first acquaintance with this very graceful and lively bird the observer is struck by the wonderful ability of the bird to run very fast and easily along horizontal branches of different thicknesses. Without any visible difficulty they can climb or descend steep inclined branches (Plate I). Within their small nest-territory they usually move on foot, flying only from one tree to another, or between a tree and the ground. Unlike woodpeckers, tree creepers, and nuthatches, Forest Wagtails have no special adaptations for tree-living. In comparison with other wagtails, the legs are a little shorter and the claws, including those of the hind toe, are sharp and strongly curved.

At breeding time Forest Wagtails spend plenty of time in the crown of the trees. Numerous and prolonged observations showed that the birds can run with ease along comparatively narrow and steeply inclined branches when the bark is very rough, but not if it is very smooth. In Amurland, as in other parts of the range, oaks and Dahurian Birches serve excellently for this purpose, as well as for nest building.

As far as is known from literature, on migration and in winter quarters Forest Wagtails keep mainly on the ground. Only when disturbed they fly on to the nearest tree, run some distance along a thick horizontal branch, and fly down very soon. No preference for any definite kind of trees has been noticed at that period of its life.

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[1] except very slowly up and down while pivoting from side to side on a branch. —S.A.

NEST

In Amurland in the region of the authoress's study in 1959 the majority of Forest Wagtails had begun to construct their nests by 6th June. On 7th were met birds which had just started nest building, and on 8th and 9th June were recorded five pairs whose nests were nearly complete. At the same time (on 9th June) there were full clutches in two nests. The female alone builds the nest, with building material which she collects from the ground. Usually she visits many times a selected place which abounds in building material. At the beginning of June in Amurland oak forests one frequently comes across a number of Forest Wagtails flying in the same direction with large bunches of moss, rotten leaves, or grass in their beaks. Cautiously tracing such a bird it is easy to find a nest in course of building. The male takes no part in nest building, but is constantly somewhere near by; he accompanies his mate when bringing the building material, and is the first to notice and warn her of danger. The female is very cautious and never flies directly to the nest, even when it is building; she perches on a lower branch of a near-by tree and only after an assuring 'all clear' call from her mate does she fly to the nest-tree, running inconspicuously along the branches to the nest.

If disturbed at an early stage of nest building, the female abandons the nest and, soon after, begins to look for a new site. Later, when the nest is nearly completed, the birds become less shy and do not stop building even after a short visit by the observer.

At breeding time, as in the early period after their coming back from winter quarters, Forest Wagtails prefer the marginal and lightest parts of the forest and avoid the inner dense and high-standing parts. In all the cases known to the authoress the nests were built on medium-sized trees (5-17 m. high) growing near forest ways and vistas.

From Table I the preference given to oaks for nest building is evident. The same took place in Ussuriland (Spangenberg, 1949; Vorobiev, 1954) and east China (La Touche, 1930).

TABLE I
Position of the Nests

Serial No.[1]	Kind of tree	Height above the ground	Distance from the main trunk	Diameter of the branch supporting the nest
1	oak	7-8 m.	2.5 m.	69 mm.
2	oak	5-6 m.	3.0 m.	87 mm.
3	oak	6 m.	1.5 m.	66 mm.
4	oak	10 m.	2.0 m.	66 mm.
5	Dahurian Birch	5 m.	0.0 m.	62 mm.
6	oak	6.5 m.	0.0 m.	68 mm.
7	oak	4.5 m.	0.0 m.	..
8	oak	5.5 m.	2.5 m.	..
9	oak	4 m.	1.5 m.	..

[1] We retain these numbers throughout the text.

Horizontal branches not very thick (66-68 mm. in diameter) are very convenient for nest building. The birds usually select for building the distal part of the branch 1.5-3.0 m. away from the main trunk. A horizontal branch a little thicker than the internal diameter of the nest-cup (Table II) is a safe support, and ensures a firm position for the rather friable nest. Short additional twigs of the branch support the nest from the sides (Plate III, fig. *a, b, c*). Most of the known nests were located in the same way. Sometimes the birds use vertical verticils, either at the end of thick inclined branches at a significant distance from the trunk (Plate IV, fig. *d*) or at the top part of the trunk (Plate IV, fig. *e, f*). The nests observed in Amurland were built at a height of 4 to 10 m. above the ground. In some cases Forest Wagtails build their nests at smaller height, only 3 or even 1.5 m. above the ground.

For the construction of the nest walls the Forest Wagtails in Amurland use dry blades of grass, dead leaves, small pieces of bark or separate fibres of bark, small roots, and sometimes wool of rodents (*Pteromys volans* and *Microtus* sp.). On the outside the nests were faced with stems of green mosses, cocoons of spiders covered with small particles of soil, dead leaves, and slender little stalks. The nest built in the Dahurian Birch was decorated with numerous small papery pieces of the Asian White Birch bark. The second nest, built near the expedition camp, was ornamented with cotton wool.

The nests are so carefully and skilfully incrusted with these materials that they are hardly visible against the background of the dark bark covered with light spots of lichens. Sometimes, even at a very short distance, it is impossible to recognise the limit between the branch and the nest wall (Plate I). The cup is usually plentifully lined with thin roots and wool of the Roe Deer (*Capreolus capreolus*). Besides that, there are inside nearly each nest one or two feathers of the Hazel Grouse (*Tetrastes bonasia*), or the Ussurian Scops Owl (*Otus sunia stictonotus*), or any small passerine bird. Horse-hair, the very common lining of Forest Wagtail nests in Ussuriland and China, was recorded by the authoress in one nest only. The reason for this is the remoteness of the area of observation from human settlements. The measurements of the nests taken by the authoress appear in Table II.

TABLE II

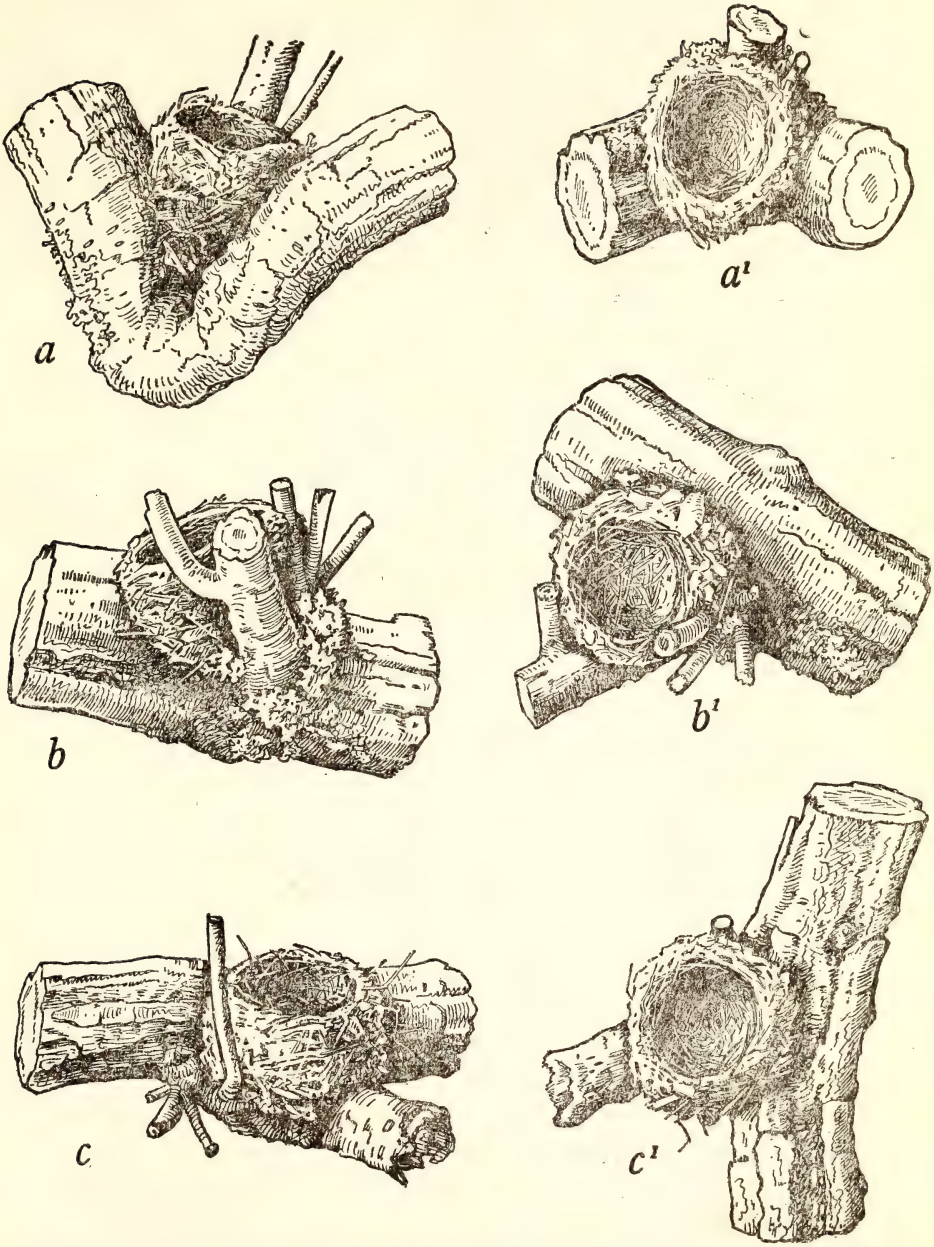
Nest Measurements

Serial No.	External height in mm.		External diameter in mm.	Internal diameter of cup in mm.	Internal depth of cup in mm.
	max.	min.			
1	74	34	86	51	34
2	70	45	91	60	40
3	80	75	88	51	40
4	62	30	91	65	40
5	89	82	84	52	42
6	61	50	87	63	35
7	60	48	90	58	33

These measurements coincide with the measurements given by Spangenberg (1949) and Vorobiev (1954) for Ussuriland. Only the external height is more variable, in accordance with the position of the nest. For instance, before the birds were able to build the nest No. 5, they had to fill with material the narrow space between the bases of the twigs in order to prepare the basement for the nest proper.

BREEDING SEASON AND EGGS

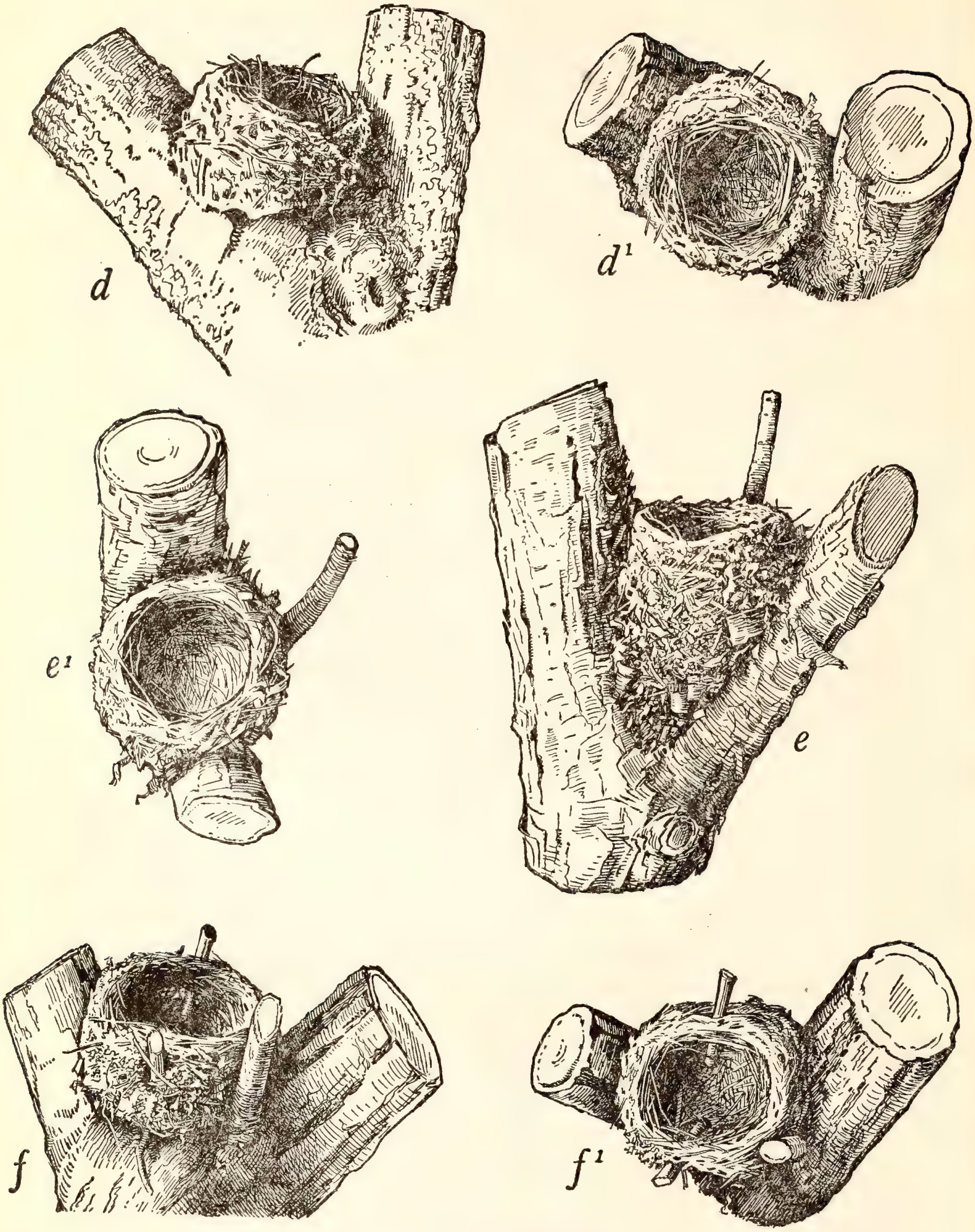
Arriving late in their breeding range the Forest Wagtails have time to breed only once. In most parts of the breeding range they



Nests of Forest Wagtail (*Motacilla indica*) on horizontal branches of oak

a,b,c : from side; a,′ b′, c′ : same nests from above

(*Drawn from nature by V. Rozhdestvenskaya*)



Nests of Forest Wagtail (*Motacilla indica*)

d : on end verticil of inclined branch of oak ; e : on vertical fork of main trunk of Dahurian Birch ; f : on vertical fork of main trunk of oak ; d′, e′, f′ : same nests from above

(*Drawn from nature by V. Rozhdestvenskaya*) begin to lay the eggs in the first half of June. According to the literature the following can be said about the breeding season. In the suburbs of Peking on 2nd July the young were leaving their nests. In Anhwei province on 8th June 1910 was found a nest with four eggs, and on 21st June with two eggs (La Touche, 1930). In Korea (Pyongan Namdo) Won collected on 3rd June 1938 a nest with five eggs (Austin, 1948). In southern parts of Ussuriland fresh eggs were recorded on 8th June 1939 (Spangenberg, 1949), and on 10 and 11th June 1946 (Vorobiev, 1954). In the collection of the Zoological Institute of the Academy of Sciences in Leningrad there are seven nestlings (14-15 days old) collected by Shulpin in the Pkhusun river valley (Ussuriland) on 5-9th July 1927. In the nests we found in Amurland the first eggs were laid: in two nests on 6th June, in two nests on 9th June, in four nests on 11-12th June, and in one nest on 17th June. The last was a case of second laying after the first slightly incubated clutch was destroyed. Spangenberg's record (1949) of nestlings on 6th June 1948 in the Iman river valley (Ussuriland) seems doubtful. It would only be possible in case the eggs were laid not later than 19th May, i.e. at an extremely early date.

The interval between nest-completion and egg-laying is one or two days. In one nest which was kept under permanent observation, attendance at the nest by the egg-laying female was recorded from 4.20-4.30 hours and again from 6-7 hours. After the egg was laid the bird stayed at the nest for some time and then flew away till the next morning. Incubation begins after the last but one egg is laid. In a case with a full clutch of six eggs the female began incubation after the fourth egg was laid. The normal clutch consists of 4 or 5, and seldom of 6 eggs. In cases of late (repeated) laying the clutch consists of 3, or even only 2 eggs.

Variation in size of eggs in the same clutch as well as in different clutches and from different parts of the range is very small. This is evident from the comparison of data from Ussuriland and Amurland (Table III), China (La Touche, 1930), and Assam (Stuart Baker, 1934).

In coloration Forest Wagtail eggs closely resemble a very common European variation of Chaffinch eggs, and sometimes the eggs of the Spotted Tree Pipit (*Anthus hodgsoni*). They have a dirty-bluish ground coloration with very sparse large grey spots concentrated principally near the blunt end of the egg. Small grey spots are distributed evenly all over the surface of the egg. Besides this, dark brown speckles, sometimes with vague rusty margins and roundish black-violet surface spots, cover the shell surface irregularly. In only one clutch were the eggs of another type of coloration: light greenish-blue ground covered with comparatively small, very indistinct brownish-grey spots, more dense near the blunt end.

The behaviour of incubating females on approach by man to the nests was varied. In some cases the female silently flew down nearly brushing the man, and then began to attract the enemy away by flying low above the ground and imitating the movements and voice of a wounded bird. In other cases the female sat in the nest very firmly and left it only when the observer began to climb up the tree and shook it. Thereafter it perched somewhere in the lower part of the crown of the tree and gave an alarm call, whereupon it was joined by its mate and sometimes other Forest Wagtails living near by.

The male always feeds its mate in the nest. Now and then the hen leaves its nest in search of food. Silently and unobtrusively it comes back to the nest, running the last part of its way along branches among dense foliage.

NESTLINGS, THE LIFE OF BROODS, AUTUMN MIGRATION

The incubation period of Forest Wagtails is 13 days. As incubation begins before the clutch is completed, the hatching of all the nestlings of the brood is not simultaneous. In fact, the female incubates for 14 or even 15 days, and the last nestling hatches one or two days later than the first ones. In nests examined in the upper Amur Valley the hatching took place from 26th June to 4th July. No addled eggs were recorded. All 39 eggs in these nests were fertilised; from 36 the nestlings hatched safely, and 3 were stolen from the nest probably by Chipmunks (*Tamias sibiricus*).

Immediately on hatching the young are blind, acoustic ducts closed, and body naked with sparse golden-grey neossoptiles above the eyes and on eyelids, nape, back, femurs, shanks, vent, shoulders, forearms (humeral region), and inner side of hand (carpal region). It is necessary to note that the nestlings of no other Motacillidae have neossoptiles on their hands. The skin on the body of a recently hatched nestling is yellowish pink, the mouth is orange-yellow, and the tongue is yellow with a grey fringe near its base. The bill is greyish with light yellow side protuberances. The weight of the hatchling is 1.7-1.9 grammes.

At the end of the first day of the nestlings' life the pterylae or feather tracts can be noticed in the form of dark areas on the dorsal

TABLE III

Egg Measurements

Locality	Serial No. of Nest	Egg Number	Absolute size (in mm.)		Average size of eggs belonging to clutch (in mm.)
			Length	Breadth	
Amurland, Neufeldt (1960)	1	I	19.2	15.0	19.1 × 14.7
		II	19.2	14.7	
		III	19.2	14.5	
		IV	19.0	14.7	
	2	I	21.5	15.0	20.6 × 14 8
		II	20.7	15.0	
		III	20.2	14.8	
		IV	20.0	14.5	
	3	I	21.5	15.3	20.9 × 15.6
		II	20.7	15.5	
		III	20.6	16.0	
	4	I	19.3	15.0	18.9 × 14.9
		II	19.2	15.2	
		III	19.0	15.0	
		IV	19.0	15.0	
		V	18.5	14.3	
		VI	18.3	14.6	
	5	I	19.5	14.7	19.2 × 14.9
		II	19.0	15.0	
		III	19.0	15.0	
		IV	19.3	14.8	
		V	19.3	14.8	
Ussuriland, Spangenberg (1949)		I	21.0	15.0	21.0 × 14.8
		II	21.1	14.8	
		III	21.2	14.8	
		IV	20.6	14.7	
		V	21.1	14.5	
Ussuriland, Vorobiev (1954)		I	19.1	14.2	19.5 × 14.4
		II	19.0	14.4	
		III	19.3	14.4	
		IV	20.0	14.4	
		V	20.3	14.6	

and partly on the ventral sides of the body. Sometimes on the second day appear the tiny needles of growing remiges. In three-day-old nestlings the acoustic ducts open, the eyes are like narrow slits, the growing primaries are about 1 mm. long, needle-like ends of growing rectrices are faintly visible, and the first feathers appear on the dorsal side of the neck. On the fourth day the feathers on the shoulders and neck begin to unfold. Next day unfold the feathers of the back, breast, and secondary coverts. In five-day-old nestlings the eyes are nearly entirely open, and their second primaries are 5-8 mm. long. On the sixth day nearly all contour feathers unfold, as far as the ends of the primaries and secondaries. The week-old nestling weighs eight times more than a newly hatched one.

In the first days of their life nestlings of the same age and of the same brood can have slight individual differences in their weight. Some days later the differences become less noticeable. For instance, in one brood the weights of three hatchlings were: 1.7, 1.9, and 1.9 gr. The weights on subsequent days were as follows:

1 day old :	3.0,	3.0,	3.2 gr.
2 days old :	4.9,	4.9,	5.5 gr.
3 days old :	6.3,	6.4,	6.9 gr.
4 days old :	8.3,	8.5,	8.6 gr.
5 days old :	10.2,	11.0,	11.2 gr.
6 days old :	11.0,	11.7,	11.6 gr.
7 days old :	14.3,	14.5,	14.5 gr.
10 days old (just before leaving nest) :	17.0,	17.0,	17.2 gr.

It is evident that the differences in weight become progressively less noticeable.

The case is somewhat different with nestlings hatched one or two days after other nestlings of the same brood. For instance, in one nest the fourth nestling hatched one day later than others. Just after hatching it weighed 1.7 gr., when it was one day old 3.0 gr., two days old 3.8 gr., four days old 6.5 gr., five days old 8.0 gr., six days old 9.7 gr., seven days old 12.5 gr., ten days old 15.3 gr. On the first two days of its life this nestling was of the same weight as its brood-mates. But it was younger, and it is common in birds that elder nestlings receive more food than the younger ones. For this reason the difference in weight between it and its brood-mates sometimes rose to 3.2 gr. It is necessary to note that in none of the nests which were under everyday observation was there registered any influence of such difference in weight upon development of feathers, acquirement of sight, etc.

Sometimes on the ninth, and as a rule on the tenth, day of their life, nestlings begin to jump out of the nest on being disturbed by the observer. In normal conditions they leave their nest on the eleventh or even on the twelfth day. Owing to difference in age the younger nestlings may leave the nest one day later than the elder ones.

The total nesting period, from the laying of the first egg to the leaving of the nest by the last nestling, is 28-30 days.

Nestlings, just after they leave the nest, are rather well feathered. To the age of 14 days solitary down feathers can still be noticed on the head and the back. Nestlings which have just left the nest weigh 17.2-18.0 gr., i.e. the same as their parents (♂♂ 17.2-18.4 gr., ♀♀ 17.7-18.9 gr.).

During the first two or three days the brood remains at a very short distance from its nest in spite of the young being able to flit rather easily from one branch to another. From the age of 17-18 days the young birds become able to fly fairly strongly. Like the adults they spend much time in the crown of the trees, where they run without any difficulty along horizontal and inclined branches of different thicknesses. A tame young Forest Wagtail, which lived in our camp in 1959, preferred to climb to the shoulder of a sitting man 'on foot' in spite of being able to fly quite well. On its way it made full use of all creases in the cloth. Frequently the young birds descend to the underbrush following their parents searching for food on the ground. But very often, before they begin to search for their food independently, they keep themselves in the lower parts of the crown of the trees. Fully plumaged young birds are on the whole similar to the adults. The difference is in the predominance of greyish and brownish shades on the upper parts of young birds; moreover the double band across the breast is not so distinct and broad as in adults (Plate II).

For some time after leaving the nest young birds keep in families, but very soon they become independent and broods disintegrate (from the middle of July on the upper Amur). Adult birds keep in pairs or solitary in oak groves, and the young belonging to two or three broods unite in small flocks and migrate to the outskirts and thinned-out parts of the wood. Here, Spotted Pipits, nuthatches, and tits are often seen in company with flocks of young Forest Wagtails. Being very silent, the Forest Wagtails are hardly noticeable at that period.

Males and females take an equal share in feeding the young. Spiders, small grasshoppers, butterflies, beetles, and large cicadas were recorded as food at that time. In Amurland during nearly all the summer, cicadas and their moulting nymphs predominated in the diet of the adult birds. They search for food preferably on the ground, picking up insects from grass, forest litter, bases of tree trunks, lower branches and leaves of bushes. According to the literature, in other parts of the area and in winter quarters Forest Wagtails pick up not only insects, but small snails, molluscs, and worms. In Ceylon in search of maggots they very often peck at cattle dung. Owing to this habit the Singalese call them *Gomarita,* i.e. dung-spreader (Jerdon, 1863). At the end of July and in August in Amurland they collected their food mainly in crowns of trees. According to Stuart Baker (1926) they can pursue insects in the air.

Forest Wagtails spend a little more than three months in their breeding range. The birds breeding at the northern limit of the area begin movement to the south even at the end of August. In China (Hopei province) they disappear at the beginning of September (Shaw, 1936; Wilder & Hubbard, 1938). They stay much longer in Korea, and some of them, as stated above, winter there. Among the birds examined by Austin (1948) were specimens collected in Kyonggi Do province on 13th October.

According to the literature Forest Wagtails appear in their winter quarters on the following dates. In the western and southern parts of Yunnan in September, in Kwantung and Kwangsi in August (Caldwell & Caldwell, 1931), in Hupeh in October (La Touche, 1930). In Thailand between Wiang Pa Pao and Chieng Mai in 1914 the earliest birds were recorded on 23rd August (Gyldenstolpe, cited by Deignan, 1945), in Burma near Thandaung probable migrant birds were noticed on 24th September (Smythies, 1953), in the Malay peninsula they appear at the end of September (Robinson, 1927), and in Ceylon in the first week of October (Legge, 1880). In Java the first specimen in 1909 was taken on 29th September (Bartels, 1910).

In their winter quarters Forest Wagtails keep to different kinds of forest, especially jungles thinned out by felling, and openings, ways, and paths in tropical forests. Shady parks and orchards are also visited. In Travancore-Cochin they are commonly seen in the coffee and cardamom plantations (Ali, 1953). In Ceylon according to Legge (1880) they are rather common under tamarind trees and banana plants in small Singalese jungle villages. According to the majority of literature data only solitary birds or pairs were recorded at the non-breeding time. As an exception, Robinson (1927) observed in the Malay peninsula large flocks of Forest Wagtails after storm and heavy rain.

THE MOULT

Even the very scanty materials we have had at our disposal show the marked difference in the process of the moult between young

Forest Wagtails and young White Wagtails. According to Heinroth (1926) the White Wagtail acquires the complete juvenile dress (including all small feathers, remiges, and rectrices) at the age of one month and, only 1.5 weeks after the juvenile dress is completed, they start a partial post-juvenile moult. Contrary to this, in the Forest Wagtails the partial post-juvenile moult begins long before the growth of remiges and rectrices is completed. So, even in 11- or 12-day-old nestlings at the edges of the pteryla gastralis and somewhere on the neck and sides of the upper breast can be noticed apexes of feathers of the dress that is to follow. The pteryla gastralis (on the abdominal region), very small in nestlings, becomes somewhat larger due to the appearance of new feathers. At the two-weeks-old stage many contour feathers of the juvenile plumage moult and are substituted by feathers of the first-winter plumage. The lesser wing coverts and the feathers on the sides of the upper breast are the first to moult. By the 20-22nd day large bunches of new feathers appear on the breast and scapulars. The median wing coverts and the small feathers on the head and throat are still in quill at that time. Four or five days later the upper and under tail coverts moult. In Forest Wagtails 30-36 days old the growth of the remiges and rectrices is completed; in contrast to this, White Wagtails of this age have very few juvenile contour feathers in their plumage. Only the secondary coverts and a few feathers on the sides of the upper breast are still growing at that time. In 45-day-old birds the moult is completed (in Amurland at the end of July or the beginning of August). From that age young birds wear the complete first-winter plumage, practically indistinguishable from the fresh autumn dress of adult birds. In the following autumn the young birds have the first complete moult, when they change all contour feathers, remiges, and rectrices.

In the upper Amur area the complete autumn moult of adult birds begins in the second half of July, i.e. simultaneously with the end of the nesting period. The contour feathers and the primaries moult at the same time, the direction of the moult of the primaries being from the 10th to the 1st, including the rudimentary one. The moult of the secondaries (from the 1st to the 9th) and the rectrices (from the outer to the central ones) begins a little later. The moult of the adult birds is very intensive, as can be seen from the following description of moulting birds, taken in Amurland in 1959:

1. 22nd July, adult female: contour feathers on the back and breast and all secondary coverts are in sheath or the tips of some feathers have started to emerge from their sheaths; primaries of the

right wing: 10th=7/8 of the normal length, 9th=1/3, 7th is in sheath; primaries of the left wing: 9th=4/5, 8th=4/5, 7th=1/2, 6th is in sheath.

2. 25th July, adult male: all the contour feathers are moulting, the secondary feathers sheathed; primaries (symmetrically in both wings): 10th are full-grown, 9th=5/6, 8th=1/2, 7th=1/3 of the normal length, 6th are in sheath.

3. 25th July, adult female: contour feathers are moulting; primaries: 10th=1/2, 9th=1/5 of the normal length, 8th started to emerge from their sheaths, 7th are in sheath, 6th recently sheathed.

4. 7th August, adult female: more than 50% of all the contour feathers are intensively moulting; all the secondary coverts are in sheath; 1-7th secondaries renewed and grown up to the normal length, 8th=2/3 of the normal length, 9th are in sheath; primaries: 10 and 9th are new ones, 8th=6/7, 7th=4/5, 6th=1/2 of the normal length, 5th started to emerge from their sheaths; the primary coverts are at the same stage; rectrices: 1st (external pair) are in sheath, 2nd started to emerge from their sheaths, 3rd=1/4 of the normal length, 4th sheathed.

Due to absence of seasonal dimorphism in Forest Wagtails and the lack of bird skins from winter quarters, we cannot answer the question about the number of moults every year in this species. In spring all the birds arrived at their breeding places have rather faded plumage without the olive shade characteristic of the fresh autumn plumage. For this reason it is possible to conjecture that Forest Wagtails have only one complete autumn moult. But Deignan (1945) said that the specimen taken in Thailand on 19th March 'is undergoing prenuptial moult'!

ACKNOWLEDGEMENT

The author is deeply indebted to Professor A. I. Ivanov, Head of the Department of Birds of the Zoological Institute of the Academy of Sciences of the USSR, Leningrad, for his kind help and encouragement.

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A Redescription of the Indian Termite, *Odontotermes bellahunisensis* Holmg. & Holmg., with Description of a new Subspecies from Rajasthan

BY

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Zoological Survey of India, Calcutta

(*With 2 plates, 2 text-figures, and 5 tables*)

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I. INTRODUCTION

The original description of the Indian termite *Odontotermes bellahunisensis* (Isoptera, family Termitidae, subfamily Metatermitinae) as given by Holmgren & Holmgren (1917, pp. 150-151) is extremely meagre and is unaccompanied by any illustrations, so that it is virtually impossible to recognise the species from the description alone. Fortunately, the cotype material, consisting of all the castes (alates, soldiers, and workers), is present with the Zoological Survey of India. We, therefore, take this opportunity to redescribe the species more fully and to give adequate illustrations for easy recognition. One of the cotype soldiers has been selected as the lectotype.

The species was hitherto known only from the original locality, viz. Bellahunisi (in the Bellary District) and Bangalore, both in the Mysore State, southern India. Recently, we found it from the arid zone of Rajasthan (western India) and Sind (West Pakistan), but these specimens constitute a new subspecies which we describe below.

This paper is a part of the work done under the Termite Research Scheme (Taxonomy), financed by the Indian Council of Agricultural Research.

II. REDESCRIPTION OF *Odontotermes bellahunisensis* HOLMGREN & HOLMGREN

Odontotermes bellahunisensis Holmgren & Holmgren

(Plates I & II; Text-fig. 1; Tables 1-3; and Appendix)

1917. *Odontotermes bellahunisensis* K. Holmgren & N. Holmgren, *Mem. Dept. Agr. India,* Calcutta **5** (3), pp. 150-151 (imagos, soldiers, and workers). *Type-localities* : INDIA : Mysore State : Bellahunisi (Bellary District), and Bangalore.

(*a*) MATERIAL

Two imagos, 6 soldiers, and 5 workers (1 major and 4 minor), all cotypes, in spirit in a vial, Z.S.I. Reg. No. 5616/20, from Bellahunisi, Bellary District[1], Mysore State, India, coll. *T. B. Fletcher*, 30-viii-1912, 'issuing from hole in gravelly soil at dusk. No mound at all.'

(*b*) DESCRIPTION

1. IMAGO (Table 1; and Plate 1).

General. Head-capsule and mandibles brownish yellow, apices of mandibles darker; clypeus labrum, and antennae pale yellowish white; eyes black with pale ocular sclerites; thorax and abdomen brownish yellow. Head and body densely covered with fine hairs. Total length (without wings and antennae) *c.* 11.6-12.3 mm.

Head. Head-capsule subcircular, broader than long (width with eyes 2.20-2.25 mm.; length 1.75-1.80 mm.); sides convex, posterior margin rounded; frons slightly sloping in front. *Fontanelle.* Small, rounded, not prominent; lying a little above the middle of head. *Eyes.* Present as a pair of large, subround compound eyes, one on either side, protruding laterally; maximum diameter 0.60-0.63 mm. *Ocelli.* Two lateral oval ocelli present, one on either side; separated from the eyes by a little more than half their long diameter. *Antennae.* With 18 segments; segment 1 cylindrical, longest; 2 more than half as long as 1; 3 subequal to 2 and partially subdivided into a proximal and a distal half; 4 shortest; 5 slightly longer than 4; 6-11 increasing in size in that order; 12-14 subequal, slightly longer than 11;

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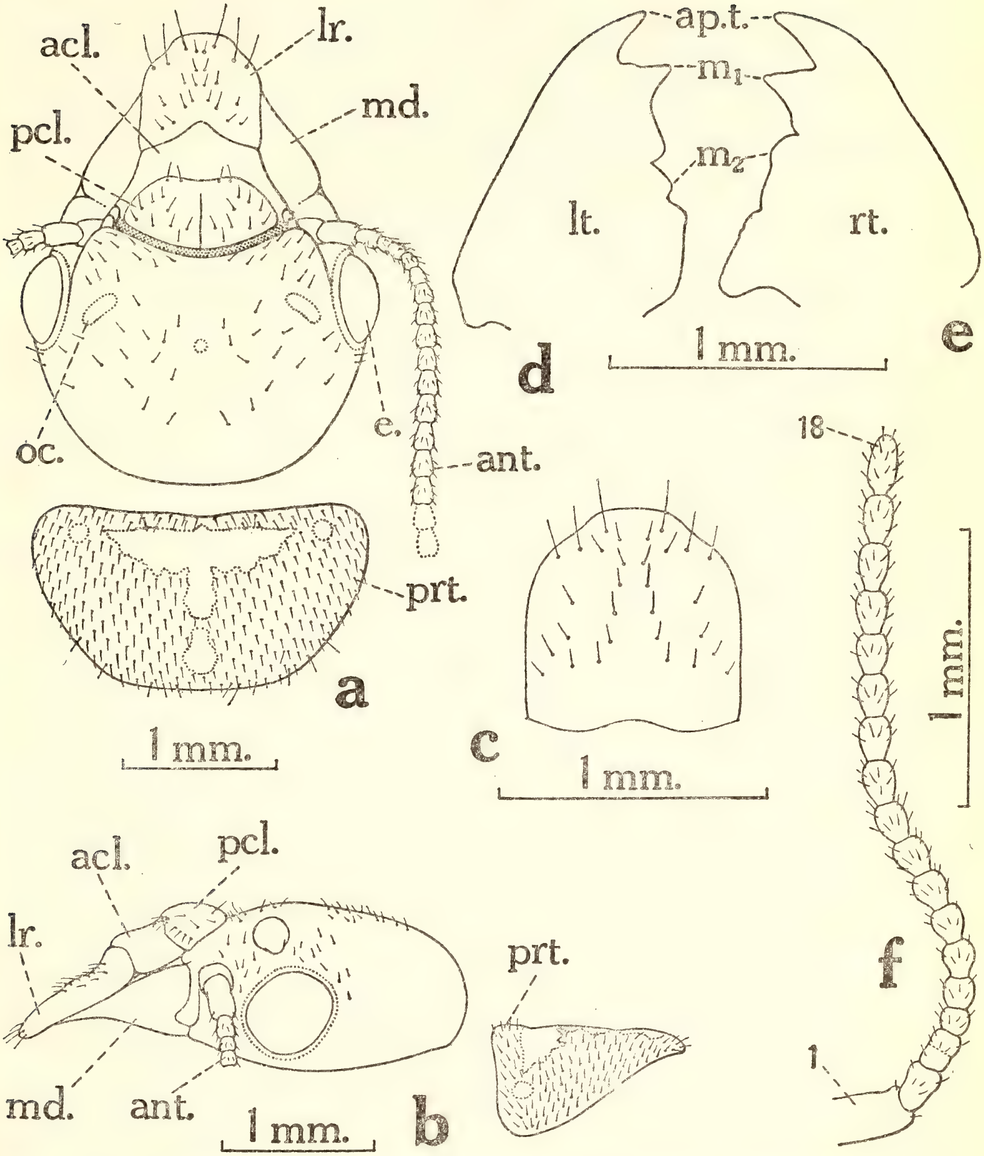
[1] Bellary District was formerly in the Madras State but was transferred to the Mysore State during the reorganisation of States in 1957.

15-17 subequal, slightly longer than 14; apical (18) ovate, more slender and longer than the penultimate one. (In another specimen with an incomplete antenna, with 15 segments; segment 3 and 4 subequal; 5-14 increasing in size in that order; and 15 shorter than 14.) *Labrum.* Tongue-shaped, broader than long; tip broadly rounded; with a few hairs on tip and on body. *Clypeus.* Divided into an ante- and a postclypeus. Anteclypeus narrow, pentagonal, with a small pointed median tip; apilose. Postclypeus distinctly separated from

TABLE 1

Body-measurements (in mm.) of imagos of *Odontotermes bellahunisensis* Holmgren & Holmgren : (Cotype lot)

Body-parts		Range (2 specimens)
I. GENERAL		
1. Total body-length (without wings) *c.*	..	11.6-12.3
II. HEAD		
2. Length of head to lateral base of mandibles	..	1.75-1.80
3. Max. width of head (with eyes)	..	2.20-2.25
4. Max. height of head (including ocellus)	..	1.00-1.10
5. Median length of labrum	..	0.60-0.65
6. Max. width of labrum	..	0.65-0.70
7. Max. diameter of compound eye (including ocular sclerite)	..	0.60-0.63
8. Max. diameter of lateral ocellus	..	0.23-0.25
9. Min. diameter of lateral ocellus	..	0.20-0.23
10. Min. eye-ocellus distance	..	0.13-0.15
11. Min. eye-antennal distance	..	0.23.0.25
12. Min. ocellus-antennal distance	..	0.25-0.28
III. THORAX		
13. Max. length of pronotum	..	1.15-1.23
14. Max. width of pronotum	..	2.10-2.25
15. Length of forewing scale	..	1.10-1.13
16. Length of hindwing scale	..	1.00-1.03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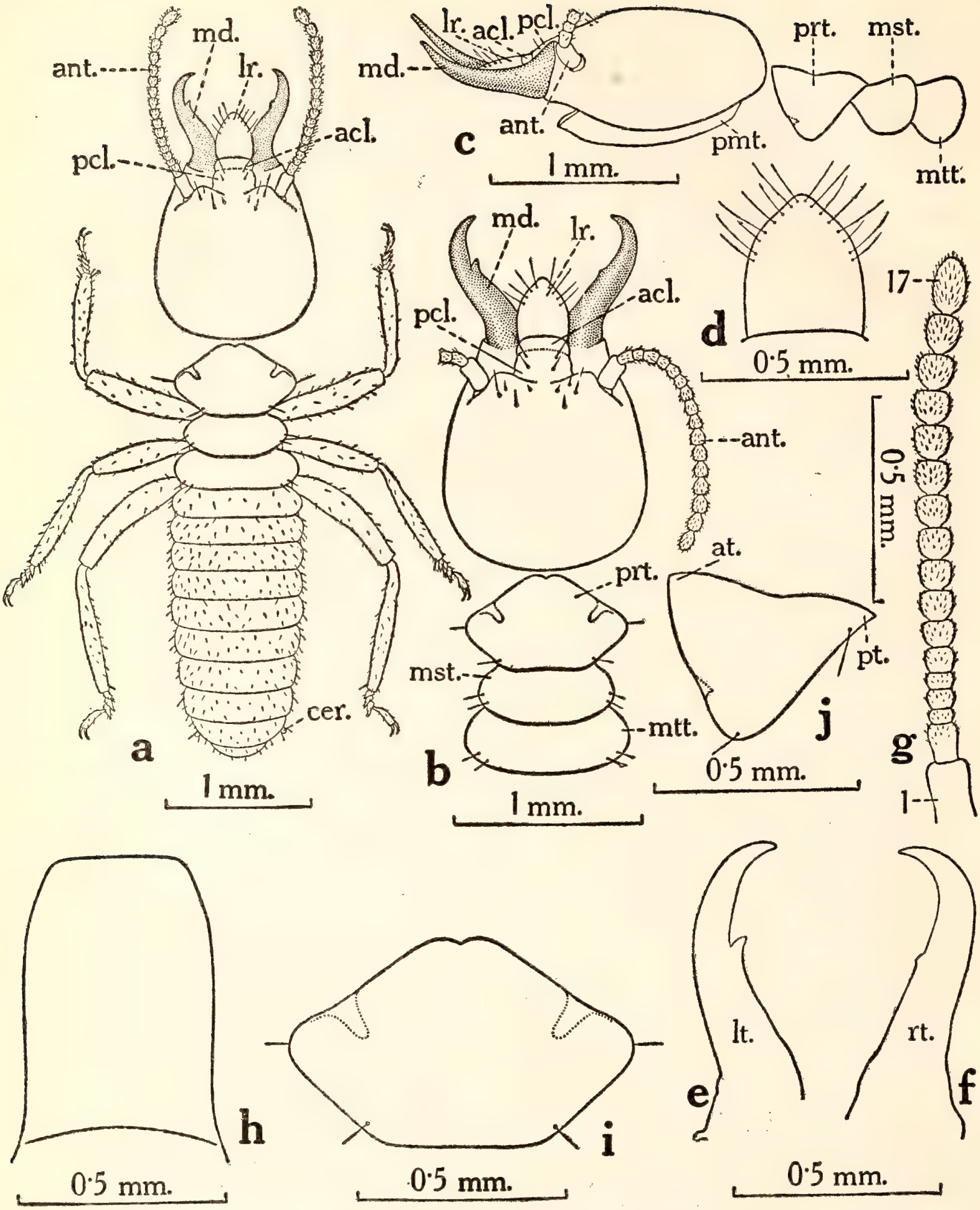
Odontotermes bellahunisensis Holmgren & Holmgren. Imago caste

Fig. a. Head and pronotum, in dorsal view ; Fig. b. Head and pronotum, in lateral view ; Fig. c. Labrum ; Fig. d. Left mandible ; Fig. e. Right mandible ; Fig. f. Antenna

acl., anteclypeus ; *ant.*, antenna ; ap.t., apical tooth ; e., eye ; lr., labrum ; lt. left ; m_1, m_2, first and second marginal teeth of mandibles ; md., mandible ; oc., ocellus ; pcl., postclypeus ; prt., pronotum ; rt., right

(All drawings are from the cotype imagos; see text)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Odontotermes bellahunisensis Holmgren & Holmgren. Soldier caste

Fig. a. Whole soldier, in dorsal view ; Fig. b. Head and thorax, enlarged, in dorsal view ; Fig. c. Head and thorax, in lateral view ; Fig. d. Labrum ; Fig. e. Left mandible ; Fig. f. Right mandible ; Fig. g. Left antenna ; Fig. h. Postmentum ; Fig. i. Pronotum, in dorsal view ; Fig. j. Pronotum, in lateral view

acl., anteclypeus ; ant., antenna ; at., anterior ; cer., cerci ; lr., labrum ; lt., left ; md., mandible ; mst., mesonotum ; mtt., metanotum ; pcl., postclypeus ; prt., pronotum ; pt., posterior ; rt., right

(All drawings are from the lectotype soldier, from the cotype collection from Bellahunisi, Bellary District, Mysore State, India, present in the Zoological Survey of India, Calcutta) frons by a semicircular demarcation, strongly swollen and divided into right and left halves by a median suture. *Mandibles.* Of the *Odontotermes*-type. Right mandible with an apical and 2 marginal teeth; apical long, bluntly finger-like; 1st marginal triangular, slightly shorter than apical; 2nd short and blunt. Left mandible with an apical and 2 marginal teeth; apical long, finger-like; 1st marginal triangular, almost as long as apical; 2nd very short and blunt and widely separated from the 1st.

Thorax: Pronotum. Trapezoidal, broader than long (width 2.10-2.25 mm.; length 1.15-1.23 mm.); either narrower or subequal to head-width (with eyes); with a T-shaped apilose mark in the centre, and indistinct shoulder spots on antero-lateral corners; anterior margin slightly upturned, with a weak median notch; anterior and posterior angles rounded; posterior margin straight, without a median notch. *Wings.* Broken in the specimens available to us; only wing-scales present. *Forewing scale.* Triangular, 1.10-1.13 mm. long. *Hindwing scale.* Also triangular; shorter than forewing scale (length 1.00-1.03 mm.). *Legs.* Long, tubular, densely pilose; tibial spur formula: 3 : 2 : 2. *Abdomen.* Elongate, densely pilose. Cerci 2-jointed; 0.15 mm. long. Styli, single-jointed; 0.05 mm. long.

2. SOLDIER (Table 2; and Plate II)

General. Head-capsule, antennae, thorax and body pale yellowish-white. Mandibles light reddish-brown. Head and body sparsely pilose. Total length (including mandibles but excluding antennae) *c.* 3.95-5.03 mm.

Head. Head-capsule rectangularly oval; longer than broad (length to base of mandibles 1.18-1.33 mm.; maximum width 1.03-1.15 mm.), converging anteriorly; rounded at posterior end; frons slightly sloping in front. *Fontanelle.* Indistinct. *Eyes and ocelli.* Absent. *Antennae.* With 16-17 segments; segment 1 cylindrical, longest; 2 cylindrical, a little more than half of 1; 3 shortest in the 17-segmented antenna, and 4 shortest in the 16-segmented antenna; 5 to the penultimate one progressively increasing in size; apical oval, longer than penultimate one. *Clypeus.* Separated into an ante- and a postclypeus. Anteclypeus narrow, hyaline, apilose. Postclypeus indistinctly separated from frons and with a few long hairs. *Labrum.* Tongue-shaped, basally broad, apically converging to a slightly pointed tip; several long and short hairs present near tip and on body. *Mandibles.* Short, stout, basally broad, sickle-shaped and strongly incurved at apex. Right mandible with a minute tooth above the

TABLE 2

Body-measurements (in mm.) and indices of soldiers of *Odontotermes bellahunisensis* Holmgren & Holmgren : (Cotype lot)

Body-parts	Range (6 specimens)	Lectotype
I. GENERAL		
1. Total body-length (without antennae) *c.*	3.95-5.03	4.65
II. HEAD		
2. Head-length up to base of mandibles	1.18-1.33	1.20
3. Max. width of head	1.03-1.15	1.05
4. Max. height of head	0.60-0.65	0.60
5. Head Index I (Width/Length)	0.86.0.89	0.88
6. Head Index II (Height/Width)	0.52-0.61	0.57
7. Head Index III (Height/Length)	0.47-0.52	0.50
8. Head Index IV (Mandible length/Head-length)	0.52-0.57	0.57
9. Median length of labrum	0.30-0.35	0.30
10. Max. width of labrum	0.28	0.25
11. Min. length of mandible		
(*a*) Left mandible	0.65-0.73	0.69
(*b*) Right mandible	0.65-0.73	0.70
12. Distance of tooth from apex of mandible (left)	0.2-0.25	0.23
13. Min. median length of postmentum	0.63-0.70	0.65
14. Max. width of postmentum	0.45-0.55	0.48
15. Width of postmentum at anterior margin	0.28-0.35	0.30
III. THORAX		
16. Max. length of pronotum	0.50-0.53	0.50
17. Max. width of pronotum	0.75-0.90	0.80
18. Max. width of mesonotum	0.65-0.78	0.70
19. Max. width of metanotum	0.78-0.93	0.85
20. No. of antennal segments	16-17	17

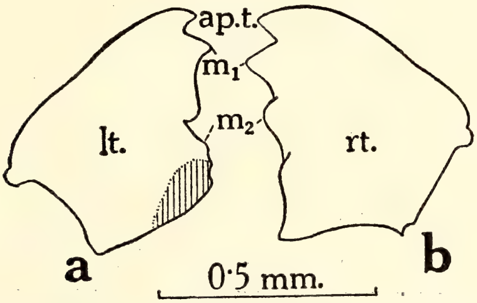
middle on its inner margin. Left mandible, with a large blunt tooth at its distal third (index Tooth distance/Mandibular length 0.29-0.34). *Postmentum.* Parallel-sided, longer than broad (length 0.63-0.70 mm.; width 0.50-0.55 mm.), slightly converging anteriorly.

Thorax: Pronotum. Weakly saddle-shaped, broader than long (width 0.75-0.90 mm.; length 0.50-0.53 mm.); anteriorly sharply narrowing; anterior margin with a median notch; posterior margin substraight. *Mesonotum.* Suboval, broader than long; narrower than pronotum; sides rounded; posterior margin weakly convex. *Metanotum.* Suboval; broader than pronotum; much broader than long; sides rounded; posterior margin substraight. *Legs.* Long, pilose; apical tibial spur formula 3 : 2 : 2.

Abdomen. Oblong, elongate, moderately pilose. Cerci 2-jointed, 0.05 mm. long. Styli one-jointed, 0.05 mm. long.

3. WORKER MAJOR (Table 3; and Text-fig. 1)

General. Head-capsule pale yellowish white; apices of mandibles and mandibular teeth dark brown. Thorax and abdomen pale yellowish-white. Head and body moderately pilose. Total length (without antennae) *c.* 3.7 mm.



TEXT-FIG. 1. *Odontotermes bellahunisensis* Holmgren & Holmgren. Mandibles of worker major. (From the cotype lot)

ap.t., apical tooth; lt., left; m_1, m_2, first and second marginal teeth of mandibles; rt., right

Head. Head-capsule subsquarish, broader than long (width 1.13 mm.; length 1.08 mm.), flattened on top; sides straight; posteriorly rounded. *Fontanelle.* Indistinct. *Eyes and ocelli.* Absent. *Antennae.* With 17 segments; segment 1 longest, cylindrical; 2 cylindrical, more than half as long as 1; 3 shortest; 4-17 (apical) progressively increasing in size; apical (17) ovate, club-shaped, longer than the penultimate one. *Labrum.* Short, broad, tongue-shaped, with a broad tip; with a few long hairs near tip and on body. *Clypeus.* Divided into an ante- and a postclypeus. Anteclypeus an apilose, narrow, strip, with a short pointed tip. Postclypeus swollen, with a few short hairs; separated from frons by a semicircular demarcation; divided into right and left halves by a median suture. *Mandibles.* Of the typically *Odontotermes*-type; teeth rather blunt and short. Right mandible with an apical and 2 marginal teeth; apical short, finger-like, 1st marginal broadly triangular, longer than apical; 2nd short, blunt, with the posterior margin longer than the anterior. Left mandible with an

TABLE 3

Body-measurements (in mm.) of workers (major and minor of) *Odontotermes bellahunisensis* Holmgren & Holmgren : (Cotype lot)

Body-parts	Range (mm.)	
	Worker Major (1 specimen)	Workers Minor (4 specimens)
1. Total body-length (without antennae) *c.* ..	3.70	3.00-3.60
2. Length of head to base of mandibles ..	1.08	0.70-0.75
3. Max. width of head	1.13	0.78-0.85
4. Max. height of head	0.53	0.35-0.40
5. Max. length of pronotum	0.40	0.35-0.40
6. Max. width of pronotum	0.63	0.53-0.60
7. Max. width of mesonotum	0.58	0.53-0.58
8. Max. width of metanotum	0.85	0.70-0.75
9. No. of antennal segments	17	16-17

apical and 2 marginal teeth; apical short, finger-like; 1st marginal triangular, slightly longer than apical; 2nd marginal minute, only slightly demarcated from margin and widely separated from 1st marginal.

Thorax: Pronotum. Saddle-shaped, broader than long, (width *c.* 0.63 mm.; length *c.* 0.40 mm.); anterior lobe strongly upturned, slightly notched medially; anterior angles narrowly, and posterior angles broadly, rounded; sides and posterior margin straight. *Mesonotum.* Suboval; much broader than long; narrower than pronotum; posterior margin straight. *Metanotum.* Suboval; much broader than long; broader than pronotum; posterior margin straight. *Legs.* Slightly swollen, moderately pilose; apical tibial spur formula 3 : 2 : 2.

Abdomen. Oblong, moderately pilose. Cerci 2-jointed; 0.05 mm. long. Styli one-jointed; 0.08 mm. long.

4. WORKER MINOR (Table 3)

Generally resembles worker major, but is smaller. *Head* subsquarish with straight sides, converging posteriorly to rounded margin.

Antennae with 16-17 segments; segment 3 varying—either shorter, or longer than, or subequal to 4.

(*c*) TYPE-SPECIMENS AND TYPE-LOCALITY

Cotypes. The following cotype material is present in spirit, in a vial, with the Zoological Survey of India, Calcutta: 2 winged imagos (wings damaged), 6 soldiers, and 5 workers (1 major and 4 minor). Bellahunisi (Bellary District, Mysore State[1], India), coll. *T. B. Fletcher*, 30-viii-1912.

Lectotype etc. Out of the above, we select one soldier (now placed in a separate vial, under Z.S.I. Reg. No. 2651/H8) as the *lectotype* and the remaining 5 soldiers in a vial, Z.S.I. Reg. No. 2661/H8, as the *paralectotypes*. The remaining cotype material (2 imagos and 5 workers) is in the original vial, Z.S.I. Reg. No. 5616/20.

Type-locality. Bellahunisi (southern India), as above.

(*d*) GEOGRAPHICAL DISTRIBUTION

The typical species is confined to southern India (Bellahunisi and Bangalore), but we have recently found a new subspecies further north, from the arid areas of western Rajasthan (India) and Sind (W. Pakistan). The new subspecies is described below.

(*e*) COMPARISONS

Odontotermes bellahunisensis is very close to the Indian species *O. obesus* (Rambur) and *O. redemanni* (Wasmann), from which, however, it is distinguishable as follows:

(*a*) IMAGOS

1. From *O. obesus* (the type-specimen of *O. obesus*, lodged in the Hope Collection, Oxford, was examined): (i) Head-capsule shorter and narrower (head-length to base of mandibles 1.75-1.80 mm. *v.* 2.00 mm., head-width with eyes 2.20-2.32 mm. *v.* 2.66 mm.). (ii) Eyes smaller (maximum diameter 0.60-0.65 mm. *v.* 0.70 mm.).

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[1] See footnote above, p. 581.

(iii) Ocelli smaller (maximum diameter 0.23-0.25 mm. *v.* 0.30 mm.); separated from eyes by a distance of more than half its maximum diameter (*v.* less than half its maximum diameter in *obesus*). (iv) Pronotum smaller (length 1.14-1.23 mm. *v.* 1.47 mm.; maximum width 2.10-2.25 mm. *v.* 2.50 mm.).

2. From *O. redemanni:* (i) Head-capsule narrower (head-width with eyes 2.20-2.32 mm. *v.* 2.66 mm.). (ii) Ocelli separated from the eye of its side by more than half its (i.e. of ocellus) diameter (in *redemanni*, by half its diameter).

(*b*) SOLDIERS

1. From *O. obesus:* (i) Mandibles shorter, stouter, and more incurved (ratio Mandible-length/Head-length to lateral base of mandibles, 0.52-0.57 *v.* 0.59-0.70 in *obesus* (*vide* Roonwal & Sangal, 1960). (ii) Pronotum without a median notch (a weak depression present in one subspecies) in posterior margin (*v.* with a well-marked notch).

2. From *O. redemanni:* (i) Mandibles shorter and more strongly incurved. (ii) Pronotum differs as in *O. obesus* above.

III. DESCRIPTION OF NEW SUBSPECIES, *O. b. guptai*

Odontotermes bellahunisensis guptai subsp. nov.

(Text-fig. 2; and Tables 4 & 5)

(*a*) MATERIAL

LOT (A): 2 tubes with 6 soldiers and several workers, coll. *S. D. Gupta*, near Bikaner, Rajasthan, India, as follows:

(i) No. T-21/16-7-52, Shivbari, Bikaner, 16-vii-1952, ex 'ground';
(ii) No. T-23/16-7-52, Ratanbai Quarters, Bikaner, 16-vii-1952.

LOT (B): 2 tubes with 6 soldiers and several workers, coll. *S. Biswas*, western Rajasthan, India, as follows. (iii) No. 1/24-10-58, Gudha near Sambhar Lake (Nagaur Dist.), 24-x-1958; (iv) No. 3/15-11-58, Sayadpura Salt Colony, near Sambhar Lake (Nagaur Dist.), 15-xi-1958.

LOT (C): 4 tubes with several soldiers and workers, West Pakistan, as follows: (v-vi) Karachi Air Port, near wireless station, coll. *A. Khan*, 13-ix-1960, ex 'cowdung'; (vii-viii) Behind 'Federal Capital Area', *c.* 10-12 km. from Karachi, coll. *Sohrab Ali*, 13-ix-1960, ex 'rotten wood'.

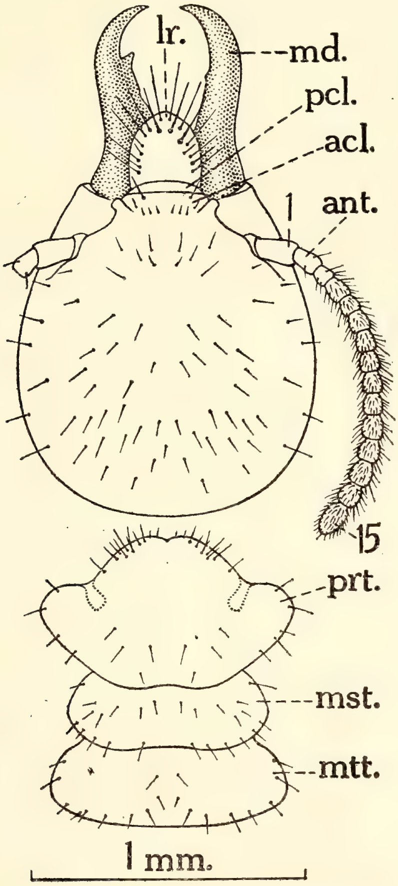
(*b*) DESCRIPTION

1. IMAGO

Unknown.

2. SOLDIER (Table 4; and Text-fig. 2)

General. Head-capsule deep golden brown to dark brown; antennae basally pale yellow, apically deep brownish yellow; anteclypeus whitish, hyaline; mandibles basally pale, apically reddish brown; thorax and abdomen yellowish white. Head and body moderately pilose. Total length (with mandibles but without antennae) *c.* 3.86-4.93 mm.



TEXT-FIG. 2. *Odontotermes bellahunisensis guptai* subsp. nov.

Head and thorax of soldier, in dorsal view (From a paratype, near Gudha village, Nagaur District, Rajasthan)

acl., anteclypeus; ant., antenna (with segments 1-15); lr., labrum; md mandible; mst., mesonotum; mtt., metanotum; pcl., postclypeus; prt., pronotum.

TABLE 4

Body-measurements (in mm.) of soldiers of *Odontotermes bellahunisensis guptai* subsp. nov.

Body-parts	Range (10 specimens)	Holotype
I. GENERAL		
1. Total length (including mandibles and excluding antennae) *c.* ..	3.86-4.93	3.86
II. HEAD		
2. Head-length to base of mandibles ..	1.08-1.20	1.08
3. Max. width of head ..	0.98-1.08	0.98
4. Max. height of head ..	0.60-0.63	0.60
5. Head Index I (Head-width/Head-length) ..	0.87-0.95	0.90
6. Head Index II (Head-height/Head-length)..	0.50-0.56	0.55
7. Head Index III (Head-height/Head-width)..	0.56-0.61	0.61
8. Head Index IV (Mandible-length/Head-length) ..	0.52-0.57	0.55
9. Median length of labrum ..	0.25-0.28	0.25
10. Max. width of labrum ..	0.23-0.28	0.23
11. Min. median length of mandibles :		
(*a*) Right mandible ..	0.60-0.65	0.60
(*b*) Left mandible ..	0.58-0.65	0.60
12. Distance of tooth on left mandible from apex of mandible ..	0.15-0.20	0.20
13. Tooth Index. (Distance of tooth from apex/Mandible-length) ..	0.25-0.33	0.33
14. Median length of postmentum ..	0.63-0.65	0.63
15. Max. width of postmentum ..	0.45-0.48	0.45
16. Width at anterior margin of postmentum ..	0.33-0.35	0.33
III. THORAX		
17. Max. length of pronotum ..	0.48-0.55	0.48
18. Max. width of pronotum ..	0.73-0.85	0.73
19. Max. width of mesonotum ..	0.63-0.73	0.63
20. Max. width of metanotum ..	0.78-0.88	0.78
21. No. of antennal segments ..	15-16	15

Head. Head-capsule suboval; longer than broad (length 1.08-1.20 mm., breadth 0.98-1.08 mm.); converging anteriorly, posteriorly rounded. *Fontanelle.* Indistinct. *Eyes and ocelli.* Absent. *Antennae.* With 15-16 segments; segment 1 longest; 2 about two-thirds of 1; 3 generally shortest, or sometimes 4 shortest; 4 longer than 3 but sometimes subequal to or even shorter than the latter; 5 longer than 3 or 4; 6 onwards gradually increasing in size in that order; apical (15 or 16) ovate, longer than the penultimate one. *Labrum.* Tongue-shaped, longer than broad, with strong hairs bordering the sides and 2 pairs of long ones near the tip. *Clypeus.* Divided into an ante-.and a postclypeus. Anteclypeus, a narrow, subtrapezoidal, apilose strip, distinctly separated from postclypeus. Postclypeus indistinctly separated from frons; with 2 prominent hairs on anterior margin. *Mandibles.* Short, stout and deeply curved inwards to a sharp tip. Left mandible with a strong tooth lying at one-third the length of mandible from the apex. Right mandible with a minute tooth a little below the distal third from apex. *Postmentum.* More or less parallel-sided; longer than broad (length 0.63-0.65 mm.; width 0.33-0.35 mm.), slightly converging anteriorly; with a few hairs near and on the anterior margin; anterior margin substraight; posterior margin concave.

Thorax: Pronotum. Saddle-shaped, broader than long; anterior margin semicircular, slightly notched in middle; sides straight, converging to a deeply-notched posterior margin.

Mesonotum. Subovate; broader than long; with a weak median notch in posterior margin. *Metanotum.* Suboval, much broader than long; posteriorly weakly concave; posterior margin with a weak median notch. *Legs.* Long; femora slightly swollen; sparsely pilose; apical tibial spur formula 3 : 2 : 2.

Abdomen. Elongate, oval. Cerci 2-jointed; 0.08 mm. long. Styli single-jointed; 0.08 mm. long.

3. WORKER (Table 5)

Similar to that of the typical form *O. b. bellahunisensis*, described above, with minor differences as follows: It is not possible to separate 'major' and 'minor' workers. The number of antennal segments is usually 17, but sometimes 16.

(*c*) TYPE-SPECIMENS

Holotype. One soldier, in spirit, in a vial, Z.S.I. Reg. No. 2652/H8, near Gudha village (Nagaur Dist., Rajasthan), coll. *S. Biswas* (Field

TABLE 5

Body-measurements (in mm.) of workers of *Odontotermes bellahunisensis guptai* subsp. nov.

Body-parts	Range (8 specimens)
1. Total length (excluding antennae) *c.* ..	2.48 - 3.90
2. Head-length to base of mandibles ..	0.98 - 1.20
3. Max. width of head ..	1.08 - 1.30
4. Max. height of head ..	0.50 - 0.60
5. Max. length of pronotum ..	0.33 - 0.53
6. Max. width of pronotum ..	0.53 - 0.70
7. Max. width of mesonotum ..	0.60 - 0.68
8. Max. width of metanotum ..	0.75 - 0.90
9. No. of antennal segments ..	16 - 17

Coll. No. 1/24-10-58), 24-x-1958; deposited in the National Zoological Collections, Zoological Survey of India, Calcutta.

Morphotype. One worker in spirit in a vial, Z.S.I. Reg. No. 2653/H8, from the holotype lot and with the same data. Deposited in the Zoological Survey of India, Calcutta.

Paratypes and *Paramorphotypes.* Deposited as follows: (i) Four paratype soldiers and four paramorphotype workers, in spirit in a vial, Z.S.I. Reg. No 2654/H8, from the holotype lot and with the same data, in the Zoological Survey of India, Calcutta. (ii) One paratype soldier and two paramorphotype workers, in spirit in a vial, from material No. T-21/16-7-52, Shivbari, Bikaner, coll. *S. D. Gupta*, with Prof. A. E. Emerson, Department of Zoology, Chicago University, Chicago, U.S.A. (iii) One paratype soldier and one paramorphotype worker, from same material as (ii), in the Entomological Collections, Forest Research Institute, Dehra Dun.

(*d*) TYPE-LOCALITY

INDIA. Rajasthan: Near Gudha village (approx. 26° 55′ N. lat. and 75° 25′ E. long.), Nagaur District.

(*e*) GEOGRAPHICAL DISTRIBUTION

This subspecies seems to be confined to the arid areas of western Rajasthan (India) and Sind (W. Pakistan), as follows:

INDIA. Rajasthan: Bikaner and vicinity (Bikaner Dist.); and near Gudha village (the type-locality) and Sayadpura Salt Colony (both in Nagaur Dist.).

WEST PAKISTAN. Sind: Karachi and vicinity.

(*f*) COMPARISON

Soldiers of *O. b. guptai* subsp. nov. differ from the typical form as follows: SOLDIERS: (i) Head and body more hairy (*v.* very sparsely pilose). (ii) Head more rounded. (iii) Antennae with 15-16 segments (*v.* 16-17 segments). (iv) Mandibles somewhat stouter. (v) Pronotum with a weak median depression in the posterior margin (*v.* without a depression). (vi) Anterior margin of pronotum more curved, almost semicircular (*v.* almost triangular).

IV. SUMMARY

1. The original description of the Indian termite *Odontotermes bellahunisensis* (Termitidae, Metatermitinae) as given by Holmgren & Holmgren (1917) was very meagre and was not accompanied by illustrations, so that it is impossible to recognise the species from that description alone.

2. The species is redescribed from the cotype material consisting of all the castes, viz. alates, soldiers, and workers.

3. A new subspecies, *O. b. guptai*, is described from the arid zone of western Rajasthan (N. India), and Sind (W. Pakistan).

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APPENDIX

Original description, in full, of *Odontotermes bellahunisensis,* as given by K. Holmgren & N. Holmgren in the following paper (1917, pp. 150-151):

Holmgren, K. and Holmgren, N. (1917, August). Report on a collection of termites from India. *Mem. Dept. Agric. India* **5** (3), pp. 2+137-171. Calcutta.

'*Odontotermes bellahunisensis,* n. sp.

Imago. Smaller than *O. obesus.*

Dark-brown. Post-clypeus somewhat tinged with brown but anterior margin of the transverse band scarcely lighter than the remainder of the head. Pronotum with a yellow T-shaped mark. Shoulder-spots indistinct. Posterior part of the T detached from the anterior. The anterior part of meso- and meta-notum also brown. Wings grey-brown with yellowish 'subcostal streak'.

Hairs moderate.

Head and antennae as in *O. obesus.* Ocelli separated from the eye by their diameter, relatively small.

Length with wings	24.00 mm.
„ without „	14.50 mm.
Breadth of head	2.32 mm.
„ „ pronotum	2.16 mm.
Length „ „	1.14 mm.

Soldier. Morphologically scarcely distinguishable from *O. obesus.* Mandibles perhaps very slightly shorter and stouter.

Length of body	3.5-4.00 mm.
Head with jaws	1.95 mm.
„ without jaws	1.15 mm.
Breadth of head	1.10 mm.
„ „ pronotum	0.80 mm.

Worker. Perhaps slightly smaller than the worker of *obesus* but otherwise indistinguishable.

Localities:

(1) Madras; Bellary District, Bellahunisi; 30th August 1912. 'Issuing from hole in gravelly soil at dusk. No mound at all.'

(2) Mysore State; Bangalore; 17th July 1912. 'Issuing from hole in ground alongside road (no mound at all) just before heavy rain. Only one hole of exit noticed.'

Critical Notes on the Orchidaceae of Bombay State

VII. *ERIA* LINDL. & *PORPAX* LINDL.

BY

H. SANTAPAU, S.J., F.N.I., AND Z. KAPADIA, Ph.D.

(*With three plates*)

[*Continued from Vol.* **58** (2) : 350]

ERIA Lindl.

Eria Lindl. Bot. Reg. t. 904, 1825, nom. cons. ; Endl. Gen. Pl. 192, 1837; Benth. & Hook. f. Gen. Pl. 3 : 509, 1883 ; Pfitz. in Engl. & Prantl, Pflanzenf. 2 (6) : 175, 1889 ; Hook. f. Fl. Brit. Ind. 5 : 785, 1890 ; King & Pantl. in Ann. R. Bot. Gard. Calcutta 8 : 115, 1898 ; Duthie, ibid. 9 (2) : 110, 1906 ; J. J. Smith, Fl. Buitenz. 6 : 375, 1905 ; Kränzl. in Engl. Pflanzenr. 50 : 15, 1911 ; Schltr. Orchid. 278, 1927 ; Holttum, Rev. Fl. Malaya 1 : 353, 1953. *Pinalia* Buch.-Ham. ex D. Don, Prodr. Fl. Nep. 31, 1825, pro syn. ; O. Kuntze, Rev. Gen. Pl. 2 : 678, 1891.

The generic name *Eria* is derived from the Greek word '*erion*'= 'wool', referring to the inflorescence and flowers which are woolly-tomentose in many of the species.

Epiphytic *herbs*. Each branch of the sympodium with a creeping basal portion ; the erect part pseudobulbous, 1- to several-noded, one-leaved near the apex only or leafy throughout, the basal portions sheathed. *Racemes* lateral or apparently terminal, with one to many flowers. *Rachis*, *ovary*, and *flowers* externally often densely woolly, rarely the leaves and the inner side of the flowers also. Dorsal *sepal* and *petals* similar, free ; lateral sepals produced at the base, connate with the foot of the column to form a more or less prominent mentum. *Lip* affixed to the foot, slightly or not at all mobile, erect, simple, or ± deeply 3-lobed ; the base of lip never forms a spur but unites with the edges of the foot ; disc 2-callate, or in the form of 2 elevated lines. *Column* free, with an elongate foot. *Anther* 2-celled, each cell again falsely 4-celled ; pollinia 8, pyriform, united in 2 groups of 4, with slender membranous caudicles. *Capsules* oblong, fusiform.

A large and varied genus of over 400 species, distributed throughout the East. It occurs in India, Ceylon, Malaya, Java, Pacific Islands, and New Guinea.

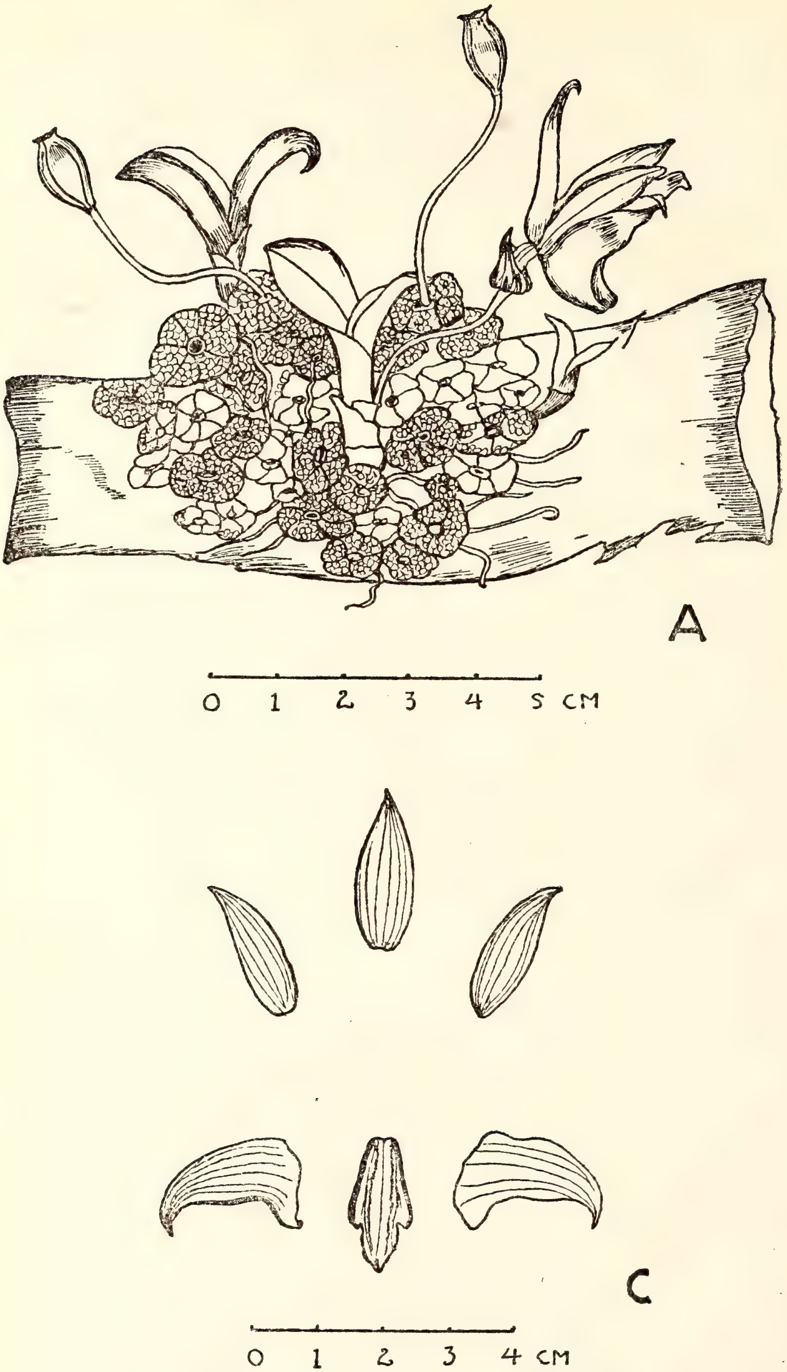
In the list of *Nomina Conservanda, Eria* is marked with a sign indicating that conservation is unnecessary. This is correct only as far as *Pinalia* Buch.-Ham. is concerned. O. Kuntze lists *Dendrolirium, Mycaranthus, Trichotosia, Ceratium, Cylindrolobus* of Blume, July 1825, as earlier names for *Eria* Lindl., Aug. 1825. Conservation against these names is certainly necessary.

Eria Lindl. has been variously divided into sections by different authors. The 5 Bombay species belong to the following 3 sections of Hooker. f. : *Eria* sect. *Conchidium* (*E. reticosa* Wt.) ; *Eria* sect. *Bryobium* (*E. dalzellii* Lindl., *E. microchilos* Lindl., *E. exilis* Hook. f.) ; and *Eria* sect. *Hymenaria* (*E. mysorensis* Lindl.).

Type species : *E. stellata* Lindl.

KEY TO THE SPECIES OF *ERIA* OF BOMBAY

1. Pseudobulbs discoid ; flowers 20-30 mm. long, solitary .. .. .. *reticosa*
1. Pseudobulbs discoid or conical-ovoid ; flowers under 12 mm. long, in racemes :
    2. Pseudobulbs conical-ovoid, 3 × 1.2 cm. ; leaves 5-13 cm. long ; scapes shorter or rarely equalling the leaves ; pedicels and ovary puberulous .. .. *mysorensis*
    2. Pseudobulbs discoid, 4-15 mm. in diam. ; leaves up to 8 cm. long ; scapes longer than leaves ; pedicels and ovary glabrous :
        3. Scape usually without (rarely with) leaves, zig-zag, 1-4 cm. long ; flowers 2 mm. long, greenish-white .. *exilis*
        3. Scape always with leaves, straight, 3-9 cm. long ; flowers 7-9 mm. long, pale yellow :
            4. Flowers secund ; bracts up to 3 times longer than ovary ; sepals and petals fringed with capitate glands, acute ; lip panduriform without callosities at the base.. *dalzellii*
            4. Flowers usually not secund ; bracts slightly longer than ovary; sepals and petals entire, without glands, acuminate ; lip narrowly obovate-lanceolate, base with 2 callosities, apex tapered, distinctly crenulate .. .. *microchilos*


A
0 1 2 3 4 5 CM
C
0 1 2 3 4 CM

Eria reticosa Wight

A. Plant with support ; C. Sepals and petals dissected.

ENUMERATION OF THE SPECIES OF *ERIA* OF BOMBAY STATE

1. **Eria reticosa** Wight, Icon. 5 (1) : 4, t. 1637, 1851 ; Hook. f. 787 ; Gammie in Journ. Bombay nat. Hist. Soc. 17 : 36, 1906 ; Blatt. & McC. ibid. 35 : 272, 1931 ; Cooke, Fl. Pres. Bomb. 2 : 690, 1907 ; Santapau in Rec. Bot. Surv. Ind. 16 (1) : 300, 1953. *E. uniflora* Dalz. in Hook. Journ. Bot. 4 : 111, 1852. *E. braccata* Dalz. & Gibs. Bomb. Fl. 262, 1861 (non Lindl. 1859) : Kränzl. in Engl. Pflanzenr. 50 : 18, f. 1 A-B, 1910 ; Fyson, Fl. Nilg. Puln. Hill-Tops 2 : 386, t. 243, 1915 ; Fischer in Gamble, Fl. Pres. Madr. 1425, 1928 (an Lindl. ?). *Pinalia reticosa* (Wight) O. Kuntze, Rev. Gen. Pl. 2 : 679, 1891. *Eria rupestris* Blatt. & McC. in Journ. Bombay nat. Hist. Soc. 35 : 270, f. 6, 1931. (See Plate XXXIV).

Epiphytes or *lithophytes*. Pseudobulbs 7-15 mm. across, discoid, covered with a reticulate sheath, which becomes loose on drying. *Shoots* 1-2, arising from the base of the pseudobulb, sheathed at the base ; sheaths 2-3, each 7-13 mm. long, cylindric, oblique at the mouth, denticulate, mucronate, greenish below, dingy purple above. *Leaves* 2, appearing together with the flowers, 2-7 × 0.8-2 cm., ovate, broadly oblong or oblong-lanceolate, tapered at base, acute, mucronulate, entire, dark green, often tinged with brownish purple. *Buds* boat-shaped, pale greenish purple. *Scapes* 1-flowered, arising from the upper sheath, generally from the side, about 1 mm. thick, 2-4 cm. long, purplish, curved by the weight of the flower. *Flowers* white, variable in size, sweetly and strongly scented. *Pedicels* with ovary 4-5 mm. long, slightly curved, white within the bract, light brown on emergence. *Bracts* 9 × 3-5 mm. membranous, pale brown-purple, almost orbicular in outline, cordate, mucronate, sheathing pedicel and ovary to a little more than half their length ; margins frilled, wavy, slightly turned outwards ; midrib and 2 lateral veins distinct. *Sepals* subequal, white or often suffused with pale pink, broadly oblong-lanceolate, mucronate, entire, glabrous, 9-nerved ; dorsal sepal 20-37 × 5-7 mm.; lateral ones 19-34 × 5-7 mm., somewhat broadly falcate ; mentum 8-11 mm. long, curved, oblong-conical, white, emarginate. *Petals* 18-32 × 5-7 mm., white, often suffused with pink, oblong-lanceolate, acute or submucronulate, 7-nerved, glabrous. *Lip* 19-23 mm. long, oblong-obovate in outline, sessile on foot of column, 3-lobed ; lateral lobes 5-7 × 1-2 mm., narrowly oblong, ± ear-like, acute or rounded, entire, red-margined, with 2 orange-yellow crests running from base of lip to beyond lateral lobes ; tips of lateral lobes and area in between orange-yellow ; midlobe 8-10 × 4 mm., oblong, often slightly dilated in apical half, rounded or tapering at apex, crenulate. *Column* short, white, tinged with green ; foot 10 × 3 mm., curved, narrowly oblong, yellow with reddish purple margins and parallel purple veins on inner face, paler towards apex. *Anther* 3 × 3 mm., white above, reddish inside, obovate-oblong, produced into ± conical apiculum in front, subconcave at back; pollinia 8, yellow, the upper 4 ovoid-oblong, lower 4 minute, all attached to short granular membrane. *Stigmatic surface* pale green with stellate marking in centre. *Capsules* 12 × 8 mm., oblong to obconical, truncate at apex, erect, with 6 strong ridges.

Flowering : June to July. *Fruiting :* August to March.

Occurrence in Bombay State : KONKAN : *Woodrow.* W. GHATS : *Dalzell* ; Khandala, *Blatter ex Santapau* ; Lonavla, *Gammie* ; Panchgani, *Blatter* 228-229 ; *May Langham* ; *Kapadia* 1348-1349, 2052-2053 ; Mahableshwar, *McCann* ; *Sedgwick* 7631 ; *Santapau* 13225 ; *Kapadia* 610, 615, 1198, 1200, 2094-2095 ; Ramghat, *Ritchie.* N. KANARA : Castle Rock, *Bell* 4336 ; *Kapadia.*

Distribution : Konkan, W. Ghats, southwards to Nilgiris and High Wavy Mountains.

Notes : On perpendicular rocks or tree trunks in open situations, always directly facing the monsoon currents.

We have examined *Blatter* 228, 229, 'Co-types' of *E. rupestris* Blatt. & McC., and have collected fresh material from its type locality. Blatter & McCann distinguish their *rupestris* from *reticosa* Wt. by the presence of a bilobed mentum. But Wight's Icon of *E. reticosa* shows the mentum emarginate, and in appearance bilobed. After careful examination of fresh flowers we can see no difference by which to keep the two species apart. There are, however, considerable variations in the size of the floral parts, the Panchgani flowers being considerably smaller than those collected from Mahableshwar.

2. **Eria mysorensis** Lindl. in Journ. Linn. Soc. 3 : 54, 1858 ; Hook. f. 793 ; Gammie 37 ; Cooke 692. *E. pubescens* Wight, Icon. 5 (1) : 4, 1851 ; Hook. f. 793 ; Kränzl. 64 ; Fischer 1425 ; Blatt. & McC. 275 (non Lindl. 1825). *E. polystachya* Wight, Icon. t. 1634, 1851 (non. A. Rich. 1841). *Pinalia mysorensis* (Lindl.) O. Kuntze, Rev. Gen. Pl. 2 : 679, 1891.

Pseudobulbs 3 cm. long, about 1.2 cm. broad at the base, conico-ovoid, sheathed; the older ones dry, rugose, irregularly and longitudinally furrowed. *Leaves* 3-5, arising ± from apical portion of pseudobulb, 5-15 × 1.2-2 cm., oblong-lanceolate or elliptic-lanceolate, acute, distinctly tapered, glabrous or sparsely pubescent. *Scapes* shorter than the leaves, rarely equal to them, 1-2 per plant ; peduncles slender, glabrous or sparsely puberulous, terete. *Flowers* 12-16 mm. long. *Bracts* about 8 × 3-4 mm. ovate or ovate-lanceolate, often reflexed, entire, glabrous, acute. *Pedicel* with *ovary* 10 mm. long, slender, curved, sparsely puberulous. *Sepals* and petals linear-lanceolate, broad at base, falcate, subacuminate, glabrous, entire, 3-nerved ; dorsal sepal 11-13 × 3 mm. ; lateral ones 10-11 × 3 mm. *Petals* 9-10 × 2 mm. *Lip*

7-8 mm. long, minutely clawed, arcuate, subcordate at base, oblong, subpandurate, about 4 mm. across the lateral lobes ; midlobe 2-3 mm. long, obovate-triangular, acute or apiculate, finely irregularly crenulate ; the base of the lip with 2 arched, slightly thickened ridges. *Column* 4 mm. long, slender, ± straight ; foot at right angles to column, about 2.5-3 mm. long, narrow. The colour of the flowers is given in the literature as white tipped with pink ; lip with purple blotches at the base, apical part yellow.

Flowering : July.

Occurrence in Bombay State : KONKAN : *Stocks.* W. GHATS : Mahableshwar, *Hallberg ex Blatter & McCann.* DECCAN : Koina Valley, below Mahableshwar, *Cooke.* N. KANARA : Law.

Distribution: Konkan, W. Ghats, Deccan, N. Kanara, western slopes of the Nilgiris.

Notes : Our description has been made from specimens examined in the herbarium of the Bot. Surv. Ind. (West. Circle), Poona, with the kind permission of the Regional Botanist.

There is a certain amount of confusion in the literature about the present and related species. The identity of *E. pubescens* Wt. with *E. mysorensis* Lindl. seems to be beyond doubt ; some of the confusion seems to have arisen with Hooker f. who assigned to the former species some of the characters of *E. polystachya* A. Rich.

In *E. polystachya* A. Rich. pedicel and ovary are densely pilose, sepals densely pilose on the outer side, lip entire, ovate-lanceolate, flowers pale yellow. *E. mysorensis* Lindl. has pedicel and ovary sparsely puberulous, sepals glabrous, lip oblong constricted in the middle, flowers white. The true *polystachya* does not seem to occur in Bombay.

3. **Eria exilis** Hook. f. Fl. Brit. Ind. 5 : 788, 1890, et Icon. Pl. t. 2074, 1891 ; Kränzl. 21 ; Fischer 1425 ; Blatt. & McC. 274. *Pinalia exilis* (Hook. f.) O. Kuntze, Rev. Gen. Pl. 2 : 679, 1891. *Eria microphyton* Schltr. in Fedde, Repert. 2 : 170, 1906. *E. minima* Blatt. & McC. in Journ. Bombay nat. Hist. Soc. 35 : 274, f. 2, 1931.

Minute *epiphytes. Pseudobulbs* 3-12 mm. across, flat, irregularly orbicular, usually in 3's forming a chain on tree trunks ; veins usually running the whole length of the pseudobulbs, rarely branching. *Leaves* sessile, appearing usually before the flowers, often persistent till flowering, 2-3, arising from a pseudostem 2-3 mm. high, lamina 2-25 × 2-11 mm., obovate-elliptic or oblong to obovate, glabrous, 7-9-nerved, tapering to the sheathing base, rounded apiculate at apex, margins entire, minutely papillate. *Scape* 1-4 cm. long, from between the leaves, sheathed at base, flexuose, capillary, bracteate at every bend. *Bracts* 1-2 mm. long, broadly ovate, cordate, cymbiform, acute or apiculate or acuminate, semi-amplexicaul, hyaline, entire, about as long as the ovary. *Flowers* up to 12 in a raceme, each 2 mm. long, subsessile, bracteate, translucently greenish white; generally only 1-2 flowers mature at a time. *Sepals* ± equal; dorsal one 2 × 1·25 mm., oblong, entire, obtuse, 1-nerved; lateral sepals 2 mm. long, 1.5 mm. broad at base, subfalcate, obtuse or apiculate; midnerve prominent, lateral pair of nerves indistinct. *Mentum* stout, saccate, about equalling the upturned tips of the sepals. *Petals* 1.25 × 0.75 mm., shorter than sepals, 1-nerved, narrowly oblong or sublanceolate, acute, broadest about the middle, entire. *Lip* 1.5 mm. long, very slightly stipitate, arcuate, oblong-ligulate, apiculate, ± equal to petals, fleshy, olive-green, enclosed within the much longer sepals. *Column* very small with 2 small hook-like arms; foot 1.25 mm. long, curved, stout. *Ovary* about 1 mm. long, oblong, with a very short pedicel. *Capsules* 5 × 1.5 mm., broadly ovoid, green, faintly ribbed.

Leaves : June to October. *Flowering :* October to December. *Fruiting :* October to May.

Occurrence in Bombay State : W. GHATS: Mahableshwar, *Cooke*; *Blatter & Hallberg* 1683; *Sedgwick* 7631; *Ezekiel*; *McCann*; *Santapau* 11873, 11979, 13133; *Bole* 329; *Kapadia* 583, 606, 611, 902, 937, 1210, 1917. N. KANARA: Anmod, *Sedgwick*; *Bell*; Siddhapur, *Sedgwick*; Jog, *Sedgwick*: Gersoppa Falls, *Hallberg & McCann* 34855; Castle Rock, *Santapau* 17695.

Distribution : India : W. Ghats, N. Kanara, Travancore. *World:* India, Siam.

Notes : Blatter & McCann give *E. exilis* Hook. f. for Bombay Presidency on the evidence of Cooke's sheet from Mahableshwar, preserved in the National Herbarium, Calcutta.

Santapau in his MSS notes points out that the type of *E. exilis* Hook. f. in Kew Herbarium (Travancore, Johnson, Herb. R. Wight Propr.) has a bracteate scape. Hooker f. in his *Icones* refers to this specimen, from which the Icon was drawn; the latter remarkably fits Blatter & McCann's description of *E. minima.*

In our specimens from Mahableshwar the petals vary slightly, being more or less half as long as the sepals; the lip more or less equalling the petals.

Blatter & McCann describe the floral bracts of *E. exilis* Hook. f. as lanceolate; but Hooker f. in his original description notes them as large and cymbiform, (this is exactly like in *E. minima* Blatt. & McC.). Actually Blatter & McCann's description of *E. exilis* Hook. f. seems to be more or less completely based on Schlechter's description of *E. microphyton* (which has been reduced to a synonym of *E. exilis* Hook. f. by Kränzlin).

The flowers of *E. exilis* Hook. f. as given by Blatter & McCann are 3 mm. in length ; on the other hand, *Sedgwick* 7631, identified by Blatter & McCann as *E. minima*, has flowers up to 3 mm. long.

It is clear, then, that *E. minima* Blatt. & McC. is identical with *E. exilis* Hook. f. and cannot stand as an independent species.

4. **Eria dalzellii** Lindl. in Journ. Linn. Soc. 3 : 47, 1858 (nom. et syn. tantum, non descr.). *Dendrobium dalzellii* Hook. in Hook. Journ. Bot. 4 : 292, 1852. *D. fimbriatum* Dalz. ibid. 4 : 292, 1852, nom., pro syn. (non Hook. 1825, nec Lindl. 1830). *Eria microchilos* Lindl. in Journ. Linn. Soc. 3 : 47, 1858 ; Dalz. & Gibs. 262 ; Gammie 36 ; Cooke 691 ; Blatt. & McC. 273 (excl. syn. *D. microchilos* Dalz.) ; (omnes descr. tantum, non nom.). *E. dalzellii* Hook. f. Fl. Brit. Ind. 5 : 789, 1890 ; Kränzl. 19 (partim). *E. dalzellii* var. *fimbriata* Hook. f. Fl. Brit. Ind. 5 : 789, 1890 ; Kränzl. 20 ; Fischer 1425. (See Plate XXXV).

Epiphytes. Pseudobulbs 0.8-1.5 cm. in diam., discoid, the principal veins white and flabellate. *Leaves* 3-5, sessile, sheathing at the base, 1-7 x 0.7-1 cm., elliptic to oblanceolate, obtuse, minutely micronulate, olive-green, paler, entire, minutely papillate at the margins, the midnerve depressed above, prominent below with 2 to 4 faint lateral nerves. *Racemes* 3-9 cm. tall, erect, generally secund or subsecund ; peduncle 3 cm. long, 0.5-1 mm. thick, greenish yellow, terete, glabrous, ebracteate, usually slightly curved. *Flowers* faintly perfumed, pedicellate, bracteate. *Bracts* 3-6 mm. long, 0.5-1 mm. broad at base, erect, pale greenish yellow, lanceolate, subacuminate, entire, curved at apex. *Sepals* and *petals* 6 × 1.5-3 cm., pale creamy yellow, triangular-ovate to lanceolate, acute or subacuminate, 3-nerved ; the margin entire with hyaline, stalked glands. *Mentum* about 0.5 mm. long, rounded, pale orange-yellow. *Petals* slightly narrower than sepals and rounded at base. *Lip* 3-4.5 x 1.5 mm., falcate, concave in basal half, straight upwards, minutely papillate, panduriform on spreading, the basal part broad, ovate with edges entire incurved, and 2 fairly thick yellowish orange ridges, which unite in the middle of lip and pass as one furrow into the white, much smaller, rounded apical lobe ; the latter has the edges somewhat crenulate and slightly decurved. *Column* about 1 mm. long, pale yellowish, oblong, broad at base ; foot 2 mm. long, ± at right angles to column, broad at base, pale yellow, tinged with orange at the obtuse apex. *Anther* ovate, yellow ; pollinia yellow, waxy, 8, in 4 pairs, each pair consisting of one broadly pear-shaped pollinium and another smaller narrowly linear. *Stigmatic surface* minute, yellowish. *Ovary* and *pedicel* 2 mm. long, curved, greenish yellow. *Capsules* 5 x 1.5 mm., elliptic to obovate.

Flowering : July to August. *Fruiting :* August to October.

Occurrence in Bombay State : Konkan : *Stocks ; Gammie ;* Wari Country, *Dalzell & Gibson.* W. Ghats : Khandala, *Hallberg* ; *Sedgwick* ; *Santapau* 233.9, 233.13, 582, 624, 720, 1036, 2244, 2451, 4613-4614, 4706, 4743, 4894, 5050, 6828, 6829, 12903, 14488, 15688 ; *Kapadia* 522, 556, 580 ; Mahableshwar, *Cooke* ; *Santapau* 13164, 13167 ; *Bole* 408 ; *Kapadia* 602-603. Deccan : Koinanagar, *Kapadia* 2885, 2901. N. Kanara : Devimane, *Hallberg & McCann* 34466.

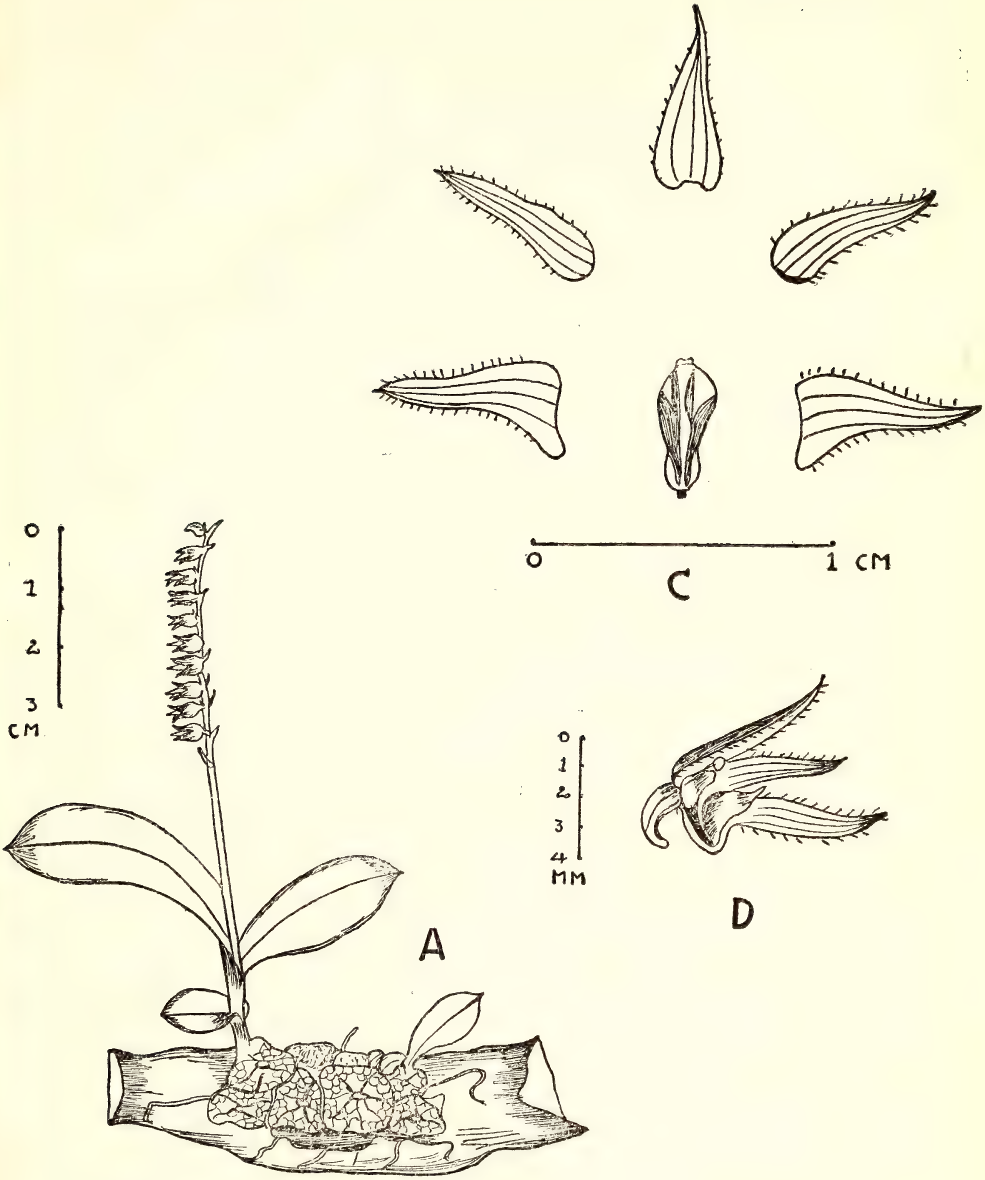
Distribution : Konkan. W. Ghats of Bombay and south peninsular India, Deccan, N. Kanara.

Notes : There is great confusion in our botanical literature about *Eria dalzellii* Lindl. and *E. microchilos* Lindl. These species are based respectively on *Dendrobium dalzellii* Hook. and *D. microchilos* Dalz. Some authors have actually fused the two species into one. We are convinced that the two species are quite distinct, and may be separated by the following characters.

E. microchilos	*E. dalzellii*
Slender herbs	More robust herbs
Peduncle ± filiform	Peduncle ± stout
Racemes not secund or subsecund	Racemes secund or subsecund
Floral bracts just longer than ovary	Floral bracts up to 3 times longer than ovary
Sepals and petals longer, acute. Margins without glands	Sepals and petals shorter, acute. Margins with capitate glands
Lip ± fleshy, scarcely lobed, ovate-lanceolate, with 2 clear callosities at base, apical portion distinctly crenulate	Lip thin, pandurate, without callosities at base, apical portion subcrenulate

5. **Eria microchilos** Lindl. in Journ. Linn. Soc. 3 : 47, 1858 (nom. et syn. tantum, non descr.). *Dendrobium microchilos* Dalz. in Hook. Journ. Bot. 3: 345, 1851. *Eria dalzellii* Lindl. in Journ. Linn. Soc. 3: 47, 1858 ; Dalz. & Gibs. 262 (partim) ; Gammie 36 ; Blatt. & McC. 273 ; Cooke 691 ; Fischer 1425 ; (omnes descr. tantum, non nom.). *E. dalzellii* Hook. f. Fl. Brit. Ind. 5 : 789, 1890 ; Kränzl. 19, f. 2 A-C (partim). *E. filiformis* (Wt.) Reichb. f. in Walp. Ann. 6 : 268, 1891 (partim). (See Plate XXXVI).

Epiphytes. Pseudobulbs 4-10 mm. across, pale dull green, discoid, principal veins reticulate. *Leaves* 2-5, sessile, 1.5-8 × 0.2-0.6 cm., oblong lanceolate or narrowly linear-oblong, distinctly tapered to the base, rounded mucronulate at apex, entire, 1-nerved. *Scape* slender, often filiform, 2.5-8 mm. long, ebracteate, pale yellow. *Flowers* usually not secund, pale yellowish white, pedicellate. *Bracts* about 3 mm. long,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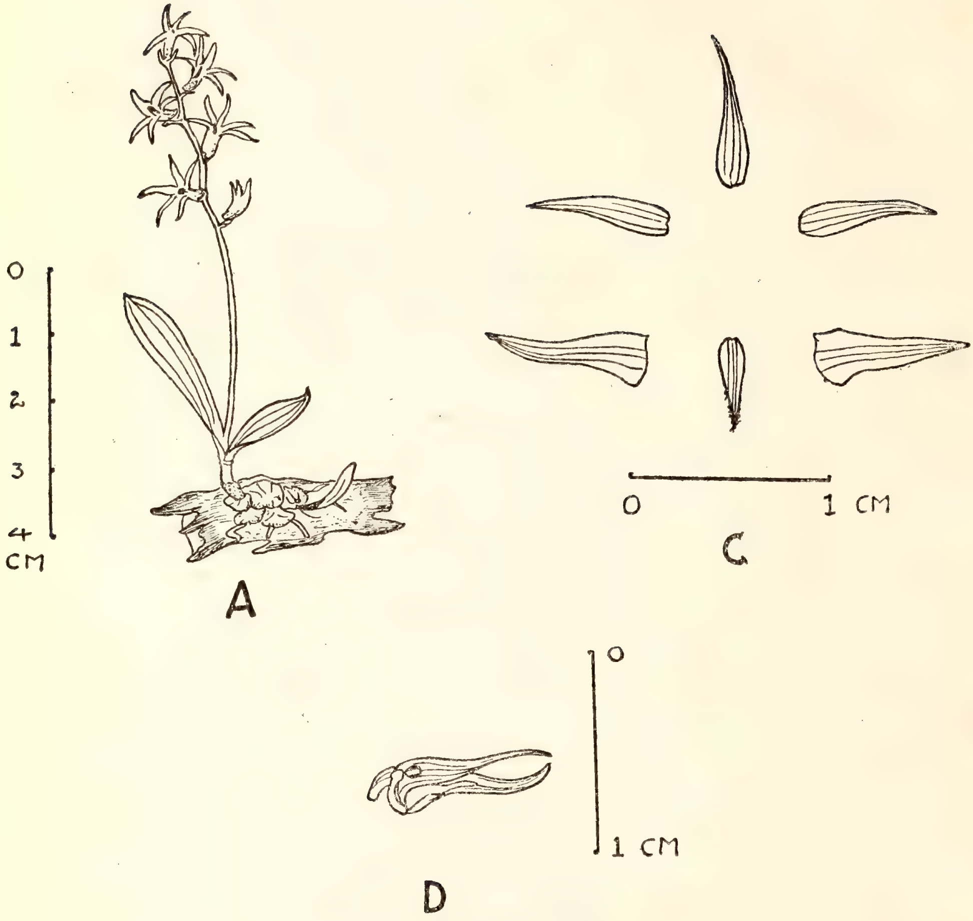
Eria dalzellii Lindl.

A. Plant with support ; C. Sepals and petals dissected ; D. Side view of single flower with lateral sepal and petal removed.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Eria microchilos Lindl.

A. Plant with support; C. Sepals and petals dissected; D. Side view of single flower with lateral sepal and petal removed.

longer than ovary, narrowly lanceolate, acute, entire. *Sepals* and *petals* pale yellowish, spreading, often slightly reflexed at apex, narrowly lanceolate-acuminate, thin, 3-nerved, margins entire without capitate glands. *Sepals* 8 mm. long, 1.5 mm. broad at base ; mentum 1.5-2 mm. long, obtuse, slightly curved, somewhat saccate. *Petals* 7 mm. long, about 1.5 mm. broad at base. *Lip* 4 mm. long, narrowly oblong-lanceolate, hardly divided; basal half about 1 mm. broad with 2 thickened yellow ridges throughout entire length; apical half very narrow, margins crenulate, much tapered to acute apex. *Column* minute, broad ; foot 1.5 mm. long, slightly curved. *Anther* more or less quadrately-orbicular with a rounded apiculum on top ; pollinia 8, in 4 unequal pairs. *Ovary* with *pedicel* 1.5-2 mm. long. *Capsules* 3-3.5 × 2 mm. long, ribbed ; stalk 1 mm. long.

Flowering : July to August. *Fruiting :* August to October.

Occurrence in Bombay State : KONKAN : *Stocks*. W. GHATS : Igatpuri, *Kapadia* 1386 ; Khandala, *Hallberg* ; *Blatter* . *McCann* ; *Santapau* 623, 2450, 4604, 4707, 4895, 6903 ; *Kapadia* 505, 533, 2297 ; Lonavla, *Chibber* ; Mahableshwar, *McCann* ; *Kapadia* 2099. DECCAN : Bhimashankar, *Kapadia* 1461; N. KANARA ; Yellapur, *Bell* 3909 ; Karwar, *Bell* ; Jog, *Sedgwick* 7171.

Distribution : Konkan, W. Ghats of Bombay, Mysore, Madras, and Kerala States, Deccan, N. Kanara.

Notes : In the field, this species stands out from *E. dalzellii* on account of the type of inflorescence ; it is not secund as in the latter species.

PORPAX LINDL.

PORPAX Lindl. in Bot. Reg. 31 : misc. 66, 1845 ; Pfitz. in Engl. & Prantl, Pflanzenf. 2 (6) : 176, 1889 ; King & Pantl. in Ann. R. Bot. Gard. Calcutta 8 : 113, 1898 ; Kränzl. in Pflanzenr. 50 : 162, 1911 ; Holttum, Rev. Fl. Malaya 1 : 393, 1953. *Eria* sect. *Porpax* Benth. & Hook. f. Gen. Pl. 3 : 509, 1883. *Aggeianthus* & *Lichenora* Wight, Icon. 5 (1) : 18, 1851.

The generic name *Porpax* is derived from a Greek word meaning ' the handle of a shield ' probably referring to the shape of the lip of the flower. According to E. Cooper (in *Dict. Gard.* 3 : 1646, 1951) the generic name refers to the form of the flower.

Minute epiphytic *herbs*. *Pseudobulbs* close together form a short rhizome, nearly flat, discoid, covered with reticulately nerved sheaths. *Leaves* 2, usually deciduous. *Flowers* solitary, sessile, terminal, large for the plant. *Sepals* more or less connate below into a tube, free and spreading above or the dorsal sepal occasionally connate up to half its length; lateral sepals somewhat oblique and prominent at the base, adnate to the column-foot, glabrous or pilose. *Petals* free, short, more or less included within the tube and inserted on the dorsal side of the column. *Lip* short, fleshy, entire or somewhat 3-lobed, loosely articulated on the foot of the column, rarely very minute. *Column* short, terete, extended into a long foot. *Anther* opercular, semi-globose or depressed, 2-celled, each of the loculi falsely 4-celled; pollinia 8, cohering in pairs, one mass in each pair being usually smaller than the other, more or less pyriform. *Capsules* small, ovoid-orbicular.

This is a small genus of about 6 species, distributed through the Malayan Peninsula and tropical Himalayas to south peninsular India and Ceylon.

The genus *Porpax* approaches nearest to *Eria*, but has the habit of *Trias* and the calyx of *Masdevallia*, as has been pointed out by Lindley. It differs from *Eria* in its habit and in the sepals which are formed into a tube.

Type species : *P. reticulata* Lindl.

Key to the species of *PORPAX* of Bombay State

Leaves developing after the flowers, obovate-elliptic or spathulate, minutely papillate, more so on margins; flowers tubular, deep red-brown, glabrous outside, papillate or pilose within	*reticulata*
Leaves appearing with the flowers, oblong-orbicular, ciliolate, tessellated; flowers 2-lipped, dirty orange-brown, densely setulose, almost tomentose outside, glabrous and smooth within	*jerdoniana*

Enumeration of the species of *PORPAX* of Bombay State

1. **Porpax reticulata** Lindl. in Bot. Reg. 31: misc. 66, 1845; Cooke 689; Kränzl. 165; Fischer 1422; Blatt. & McC. 268. *Aggeianthus marchantioides* Wight, Icon. 5 (1): 18, t. 1737, 1852, (Hook. f. et Kränzl. *A. reticulatus* per sphalm.). *Eria reticulata* (Lindl.) Benth. & Hook. f. Gen. Pl. 3: 509, 1883; Hook. f. 786; Gammie in Journ. Bombay nat. Hist. Soc. 17: 35, 1906. *Pinalia reticulata* (Lindl.) O. Kuntze, Rev. Gen. Pl. 2: 679, 1891. *Porpax papillosa* Blatt. & McC. in Journ. Bombay nat. Hist. Soc. 35: 268, f. 4, 1931; Santapau in Rec. Bot. Surv. Ind. 16 (1): 300, 1953.

Pseudobulbs about 2 cm. across, whitish green, button-like, orbicular, covered with white lacy sheaths of reticulate nerves. *Shoot* 0.5-1 × 0.2-0.3 cm., slightly dilated at the base or not, sheathed; sheath

5 × 3-4 mm., light brown, membranous, crisped, broadly oblong-suborbicular, acute, entire, minutely papillate, glabrous, gland-dotted, many-nerved. *Leaves* very small at flowering, about 5 × 3-4 mm. becoming 5-5.5 × 1.5 cm. later, sheathing, sessile, broadly oblong or obovate-elliptic or spathulate, entire, minutely papillate (papillae more prominent in young leaves), acute or rounded with a minute blackish mucro; both surfaces minutely papillate; the papillae often disappearing in old and mature leaf-surfaces. *Flower* solitary, arising from below the pseudobulb from a tube-like structure formed by the young leaves and the sheaths surrounding them; tubular, deep red-brown ("Brazil Red" [Ridg. I, 5-i] according to Santapau), very shortly pedicellate. *Pedicel* with *ovary* 3-4 mm. long, deep red-brown. *Bract* 6 × 7 mm., pale dirty brown, membranous, ± flabellate, suborbicular, retuse, irregularly denticulate, gland-dotted, 1-nerved. *Sepals* united to form a subcampanulate tube, 14 × 6-8 mm., deep red-brown, saccate at base, 3-lobed at the apex, glabrous outside, densely and minutely papillose in regular rows inside; lobes broadly ovate, rounded, mucronulate. *Petals* 8 × 3 mm., deep red-brown, parallel, reaching the sinus of the calyx-tube spathulate, subfalcate, acute, densely and minutely papillose, 3-nerved, rarely indistinctly 5-nerved. *Lip* 5 × 4 mm., panduriform, somewhat arcuate, 3-lobed, toothed at the base, shortly clawed; tooth about 2 mm. long, subulate, acute, entire, rounded at back, shallowly grooved in front; nerves of lip 3; lateral lobes 3 × 2 mm., parallel, erect, broadly triangular, rounded, entire or slightly wavy, minutely and sparsely papillose; midlobe 2 × 3 mm., broader than long, suborbicular, obtuse or subentire, irregularly denticulate, densely papillose. *Column* 2 × 1 mm., oblong, produced below into foot 2 mm. long, curved; clinandrium ± square with 2 longitudinally parallel ridges. *Anther* 1 × 1 mm., broadly oblong with a rounded apiculate apex, seated on top of column and articulated at back. *Stigmatic surface* broad, rounded, oblong; *Capsules* 10 × 6-8 mm., obovoid-orbicular, pale green, ribbed, tumid; stalk 3-4 mm. long.

Leaves: July to October. *Flowering:* June. *Fruiting:* August to October.

Occurrence in Bombay State: W. GHATS: Khandala, *Hallberg*; *Blatt. Herb.* 27629; *Santapau* 743, 823, 2150, 2252, 2620, 2808, 4516, 6930; *Kapadia* 525; Lonavla, *Kapadia* 549, 1168-1170. DECCAN: Koina Valley, *Kapadia* 2916. N. KANARA: Chandwar, *Ritchie*; Yellapur, *Kapadia* 2237-2239; Sirsi, *Sedgwick & Bell* 7002; Kumbharwada, *Bell* 6040; Castle Rock, *Kapadia* 2822-2823; Anmod, *Kapadia* 1896-1897; Guddehalli Hill near Karwar, *Bell & Sedgwick*.

Distribution: Throughout the Western Ghats, Deccan, N. Kanara, Iyamalai Hills, and South Malabar.

Notes : Khandala on the W. Ghats is the type locality of *P. papillosa* Blatt. & McC. We have examined numerous flowers of this plant, and cannot see how we can maintain it separate from *P. reticulata* Lindl. It is true that in the literature we find no reference to the papillate leaves, on which Blatter & McCann lay much stress. Such papillae are quite clear in young fresh plants, but seem more or less to disappear in old, especially dry plants. The lip is said to be ligulate, not panduriform in *papillosa ;* but in our collections from Khandala we have always found the lip to be distinctly panduriform when properly spread out. We consider *P. papillosa* to be conspecific with *P. reticulata* Lindl.

2. **Porpax jerdoniana** (Wt.) Rolfe in Orch. Rev. 16: 18, 1908; Kränzl. 163; Fischer 1422; Blatt. & McC. 269, f. 5. *Lichenora jerdoniana* Wight, Icon. 5 (1) : 18, t. 1748, 1851. *Eria lichenora* Lindl. in Journ. Linn. Soc. 3: 46, 1859; Hook. f. 787; Gammie 35. *E. jerdoniana* (Wt.) Reichb. f. in Walp. Ann. 6: 267, 1861. *Pinalia jerdoniana* (Wt.) O. Kuntze, Rev. Gen. Pl. 2: 679, 1891. *Porpax lichenora* (Lindl.) Cooke, Fl. Bomb. Pres. 2: 689. 1907.

Epiphytes or *lithophytes. Pseudobulbs* about 10 × 3-6 mm., variously shaped, often discoid with reticulately veined sheaths, olive-green. *Leaves* 2, appearing with the flowers, opposite, sheathing at the base, about 1-2 × 1-2 cm., oblong-orbicular, retuse or mucronulate, ciliolate; midnerve depressed above, prominent below, lateral ones whitish, beautifully tessellated on a deep green background. *Flowers* 2 or 3 from the centre of the leaves, dirty orange-brown, almost sessile, clearly 2-lipped, densely setulose, almost tomentose, bracteate. *Bracts* about 3 × 5 mm., transversely oblong-orbicular, membranous, translucent, sparsely gland-dotted, ciliolate. *Sepals* unequal, glabrous and deep reddish brown inside, fleshy, densely setulose almost tomentose, dirty orange-brown outside, with thick margins ; dorsal sepal 7 × 5 mm., broadly obovate-oblong to almost orbicular, obtuse, 3-nerved, concave and forming the upper lip of the flower, united at the base with the lower lip; lateral sepals united to form the lower lip, which is 9 × 5 mm., concave, connate along the foot of the column, slightly produced below to form a small globular sac. *Petals* 5-6 × 1-2 mm. pale yellowish orange, parallel, narrowly linear-oblong, ± sinuately curved and ± dilated at obtuse apex, entire, 3-nerved minutely papillate. *Lip* minute, 3 mm. long, subarcuate, ± mobile on the column-foot, minutely clawed, shallowly lobed, yellowish orange, sides erect; limb very obscurely pandurate-oblong, about 1.5 mm. broad, apical part minutely papillate, with a small obtuse apiculum which is also minutely papillate. *Column* minute, pale yellowish, foot 2-3 mm. long, slightly curved and upturned at apex. *Anther* 1 × 1.5 mm., broadly orbicular, with a minute apiculum; pollinia 8, waxy, narrowly pyriform, apiculate, all equal. *Ovary* shortly pedicellate, densely setulose, about 3-4 mm. long.

Flowering : June to July. *Fruiting :* July.

Occurrence in Bombay State: KONKAN: *Stocks*; *Law*; Tungar Hill, *N. Y. Das*. DECCAN : Koina Valley, *Kapadia* 2917-2919. N. KANARA, Belgaum Ghats, *Spooner* ; Kadra, *Bell;* Anshi, *Bell.*

Distribution : Konkan, W. Ghats of Bombay State, Deccan,N. Kanara: Bababudan Hills, Malabar and Travancore.

Notes : Our plants were found about 2 metres high on a tree trunk ; they were directly exposed to the strong monsoon blasts. It may be of interest to point out that Cooke remarks that this species is very poorly represented in Kew herbarium, there being but one specimen with imperfect flowers.

We include this species within the genus *Porpax* with some hesitation. In 1845, Lindley erected the genus *Porpax* with the type species *P. reticulata* wherein the sepals are united in a tube, the lip has a distinct erect slender tooth at the base, and each pollinium pair consisting of an obpyriform and a very narrow linear mass. In this species (*P. jerdoniana* Rolfe) the sepals are 2-lipped, the dorsal and lateral ones united at the very base only; the lip is without a tooth and the 8 pollinia masses are all equal in size and shape.

Lately we have seen very abundant material of this species collected by N. Y. Das on tree trunks at Tungar Hill, at an altitude of approx. 300 m., and 1-3 m. from the ground.

A New Genus, eight New Species, seven New Forms, and Notes on the Lepidoptera of Saudi Arabia, Bahrain, and Iran[1]

BY

E. P. WILTSHIRE

(*With 4 plates and 3 text-figures*)

The previous article in this taxonomic series dealt mainly with Afghanistan and appeared in *Beitrage zur Naturkundlichen Forschung in Sudwestdeutschland* (Karlsruhe) (Bd. **19**. H. 3, 1961). The present deals with Lasiocampidae, Nolinae, Lymantriidae, and principally Noctuidae-Quadrifinae from Arabia, Bahrain, and Iran.

The Saudi-Arabian material was mostly collected in Riadh by Dr. E. Diehl (ED) or in the Eastern Province by A. S. Talhouk (T) for the Bavarian State Zoological Museum (ZM). (In brackets are the abbreviations by which these names will be referred to below.) Some material from Kuwait in my own collection (EW) and from Saudi Arabia in the British Museum (BM) taken by Messrs. D. V. Fitzgerald (DVF), S. Gibbons (SG), McEwan (McE), A. R. Waterston (ARW) and H. St. J. Philby (P), has also been included, together with a few forms from the Hadramaut taken by Mr. G. Popov (GP).

The Bahrain material has been quite recently collected in the island-state of Bahrain, which is only separated by a sea-strait of about twenty miles from the Eastern Province of Saudi Arabia, by L. Aircraftsman D. Rush (DR) and myself (EW). This appears to be the first material from this island, which lies north of the Tropic.

The Iranian material was in part collected by me between ten and twenty-five years ago, and partly more recently for the Stuttgart State Museum (SM), by Herren Richter and Shauffele (RS) or Richter alone (R).

I am particularly grateful to Mr. D. S. Fletcher of the British Museum and to Monsieur Charles Boursin for their aid to me in my researches; also to Messrs. W. H. T. Tams, P. Viette; also Dr. B.

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[1] This is the XVIth article in this taxonomic series on the Middle East Lepidoptera. Part XVth appeared in the *J. Bombay nat. Hist. Soc.* **55** (2) : 228-37.

Alberti, and the Stockholm Natural History Museum for the kind loan of some important types.

Family LASIOCAMPIDAE

Beralade gibbonsi Wilts. (comb. nov.)

Lambessa gibbonsi Wilts., 1947, *Bull. Soc. Fouad ler Ent.* **31**, Plate Fig. 1.

This species, usually pure white, must be transferred to *Beralade* (which is closely related to *Chilena*); a good series (P) exists in the BM., all except one having the hindwing nervures 4 and 5 stalked as in these two genera, but one having them connate as in *Lambessa*. The interesting aberration described below reveals clearly the affinity to *Beralade* rather than *Lambessa* as its grey markings are oblique as in the former genus. Of the white forms from Arabia in the BM., only one example reveals traces of this oblique forewing stripe; the original *gibbonsi* type did not show it. However, a ♂ labelled Riadh 1-iii-58 (ED) shows traces of it. The species resembles *pura* Roths. superficially.

grisescens ab. nov. (Plate I, Fig. 4)

Forewing, with a faint grey-brown oblique straight line from the apex to the middle of the hind margin, but reaching neither, and a second, similar but fainter line from the margin below the apex to near the tornus, and with very slight grey powdering along the costa and termen; on the hindwing, a weakly-defined, grey broad marginal border runs from below the apex to the anal angle. Forewing underside, with a grey-brown marginal shade, and with the termen weakly (but more strongly than on the upper side) defined in grey; hindwing, with a similar but less extensive marginal shade, absent from the costa.

Holotype: ♂, Saudi Arabia, Hayir, 27-i-60, ED, ZM.

Note on affinities of *gibbonsi:* Mr. W. H. T. Tams has kindly examined the genitalia of *gibbonsi* from Arabia and of *pura* Roths. from N. Africa and found differences justifying considering them distinct species.

Family ARCTIIDAE

Subfamily NOLINAE

Celama harouni Wilts. **dilmuna** subsp. nov.

The Bahraini race, here named after the ancient name of this island (Dilmun) in Sumerian times, has a more grey-infused, cooler brown hue than the typical form of Iraq (described in *J. Bombay nat. Hist. Soc.* **49** (4) : 653-4, 1951); the latter extends into Lebanon and Persia. In some Bahraini examples, especially those flying in the desert, where however it is rarer than on oasis-ground, the forewing ground-colour is more whitish and contrasts strongly with the dark bands and scale-patches; this has not been noted in the typical form, but occurs in some examples from Saudi Arabia, Nejd, Riadh (ED) which have the warmer brown coloration of the typical form.

Holotype: ♂, allotype ♀, and three paratypes ♂♀, Bahrain (oasis), 12-ii-61, EW.

Other paratypes: same locality, different dates: 26-xii-59, 9-i-60, 26-i-60, 23-ii-60, 16-iii-61, 16-iv-61, and seven examples bred ex ovo hatched 11-14-v-61 (EW); also other examples from Bahrain (DR) in BM.

The larvae ex ovo fed on *Prosopis stephaniana* and on one or two species of trefoil; fuller details will be given in a later article devoted to larval descriptions and photographs.

The humid maritime climate, with negligible rainfall but heavy dews, of the island of Bahrain may be responsible for a tendency for the lepidoptera there to form races distinguished from the mainland forms by cooler, darker colouring, often verging on melanic, and in some cases smaller size. The melanic tendency is very marked in the Bahrain race of the Noctuid *Cerocala sana* Stgr., and the small size characterises the desert Noctuid *Scotia sardzeana* Brandt the Bahrain form of which is not different in colouring from the typical.

I refrain however from giving these island races new names in the present article, because, in the first case, *sana* is very variable both on the island and on both shores of the Persian Gulf, and in the second case, because I have never thought fit to name a form whose only distinction from others is its small size.

Family LYMANTRIIDAE

Euproctis cervina Moore

Synonyms : *E. pusilla* Moore
E. pygmaea Moore, praeoccupatum by *pygmaea* Walker
dana Swinh. syn. nov.
(nec *pygmaea* Walker)

This species is widespread in N. India and is now proved to occur north of the Tropic in the Persian Gulf. According to Mr. D. S. Fletcher, who has kindly examined the BM. material for me, it is distinct from *E. varians* Walker which is widespread in SE. Asia.

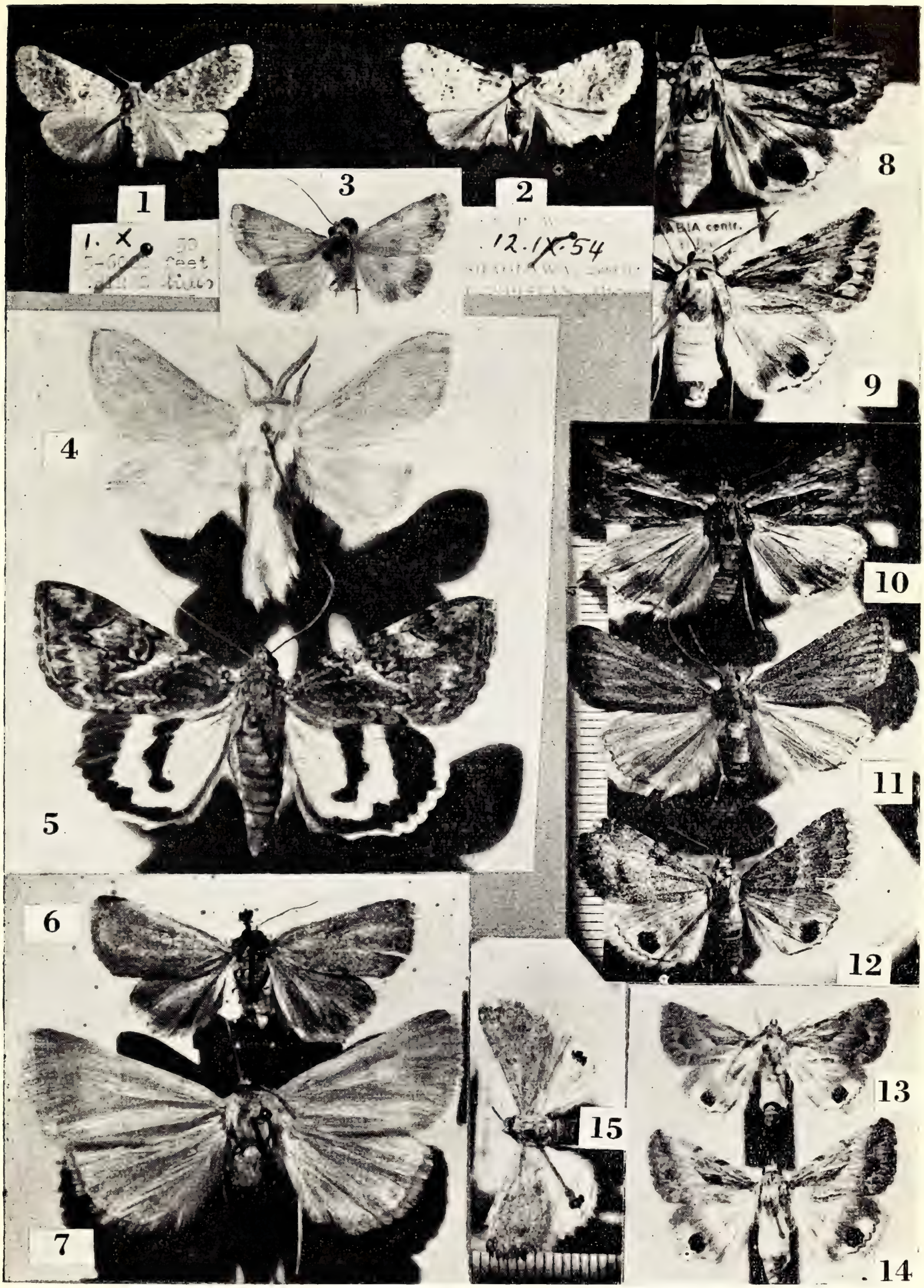


Fig. 1. *Victrix sassanica* sp. nov. (SW. Iran) ; Fig. 2. *Victrix tabora* Stgr. (N. Iraq) ; Fig. 3. *Armada fletcheri* sp. nov. (SW. Iran) ; Fig. 4. *Beralade gibbonsi* Wilts. *grisescens* ab. nov. ♂ (Arabia) ; Fig. 5. *Catocala timur* B.-H. *richteri* subsp. nov. (S. Iran) ; Fig. 6. *Cryphia polyphaenoides* sp. nov. ♀ (Bahrain) ; Fig. 7. *Lygephila fereidun* sp. nov. ♂ (N. Iran) ; Figs. 8, 9. *Anumeta asiatica* sp. nov. (8 : S. Iran, 9 : Arabia) ; Figs. 10, 11. *Anumeta arabiae* sp. nov. (Arabia) ; Fig. 12. *Anumeta sabulosa* Roths. (Arabia) ; Figs. 13, 14. *Anumeta asiatica* sp. nov. (Arabia) (× 5/7) ; Fig. 15. *Anumeta atrosignata* Walker ♂ (Arabia).

(All enlarged except figs. 13 & 14)

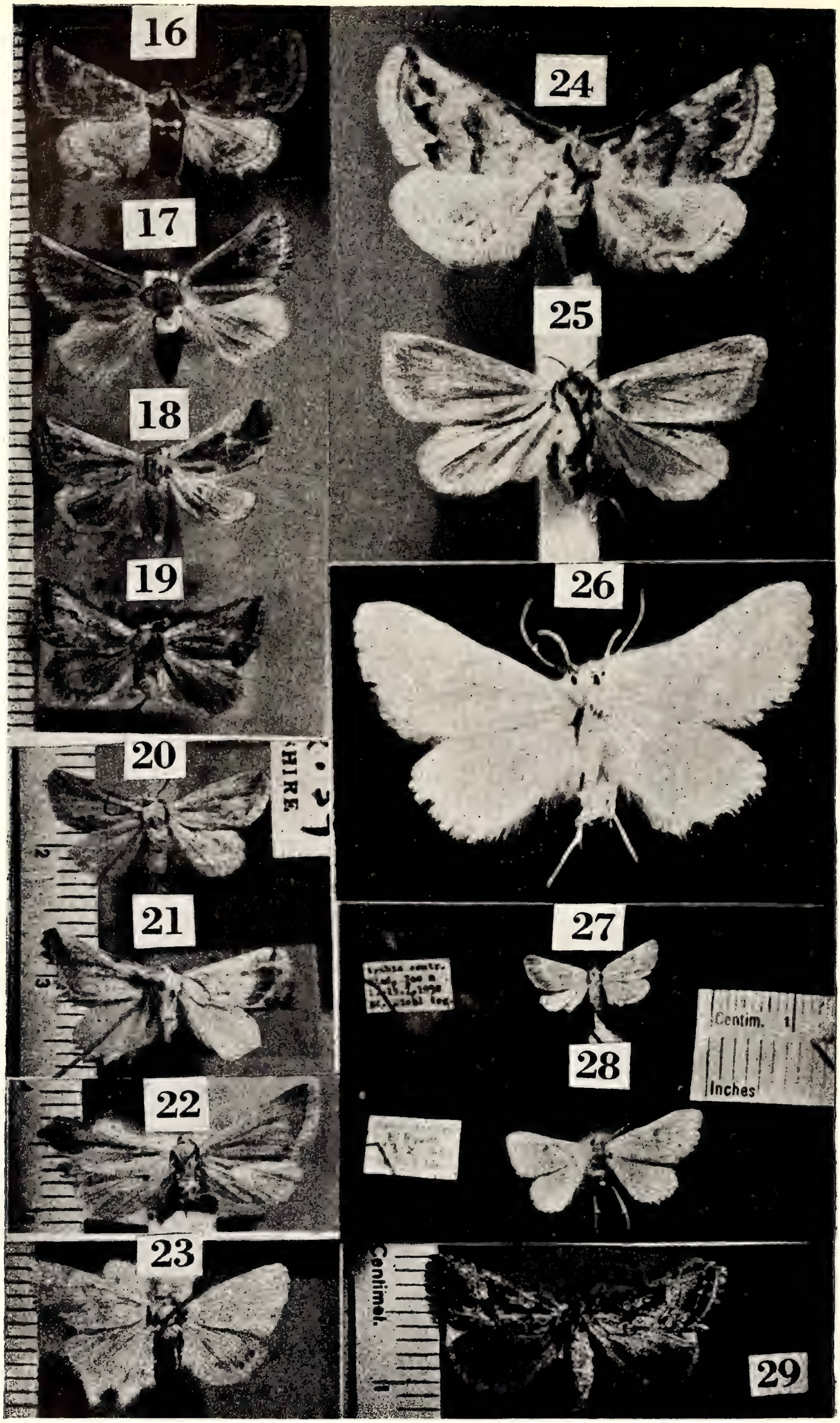


Fig. 16. *Porphyrinia rushi* sp. nov. ♀ (Bahrain) ; Figs. 17, 18. *Porphyrinia bistellata* sp. nov. (Bahrain) ; Figs. 19-21. *Porphyrinia pallidula* H.-S. *khalifa* subsp. nov. (Bahrain) ; Fig. 22. *Porphyrinia pallidula* H.-S. *khalifa* subsp. nov. (SW. Iran) ; Fig. 23. *Riadhia diehli* sp. nov. ♀ (Arabia) ; Fig. 24. *Porphyrinia rushi* Wilts. *frigida* ab. nov. (Bahrain) ; Fig. 25. *Porphyrinia bulla* Swinh. ♀ (Bahrain) ; Figs. 26, 28 *Antarchaea pyralomima* sp. nov. ♂♂ (28 = holotype) (Arabia) ; Fig. 27. *Riadhia diehli* sp. nov. ♀ (Arabia) ; Fig. 29. *Hypenodes orientis* Brandt *richteri* subsp. nov. (S. Iran).

(Figs. 16-23 : × 2 , 24-26 : × 3 ; 27, 28 : × 12/10)

I select as lectotype of *varians* Walker a ♀ from Foo-chow seen by Walker in the British Museum.

Probably *E. charmotanti* Vuillot (Seitz II, Pl. 21, i) is a N. African race, if not a further synonym, of *cervina* Moore.

E. cervina Moore inhabits Bahrain and is there locally common on oasis ground; it may well inhabit the Batina region of Oman and perhaps Qatif and Hofuf, Saudi Arabia.

The first generation flies in Bahrain in mid-March and is larger than the following generations, and often distinguished by grey-infused hindwings; the second flies in late May. A third generation flies in late summer, and is, to judge from a single representative available, the smallest and palest: its span is only 18 mm. No female has been taken yet, but the males are readily attracted to light after dark, or may be taken flying in well-watered date-palm groves at dusk.

The male genitalia of Bahrain *cervina* are illustrated in two figures (Plate III, Figs. 1, 2) herewith, as this may assist students of doubtful *Euproctis* in Africa and Asia; it should however be mentioned that the tail-parts are very three-dimensional and become distorted into variable positions under a cover-glass; this explains the apparent discrepancies between the two figures.

Family NOCTUIDAE

Subfamily TRIFINAE

Victrix sassanica sp. nov. (Plate I, Fig. 1)

Close to *V. tabora* Stgr. (=*Bryophila tabora*) and more easily distinguished therefrom in the male than the female. The male antenna is more ciliated; the genitalia also differ. Both species have variable but confused markings; the new species is usually darker, with more lead-grey infused forewing than *tabora*; it inhabits the Southern Zagros whereas *tabora* inhabits the Northern Zagros and Anatolia.

Span: 24-29 mm.

Male antenna, with ciliations as long as breadth of shaft; whereas in *tabora* it is only slightly setose.

Male genitalia (see Plate III, Fig. 4); the valve is shorter and slenderer than in *tabora* (Plate III, Fig. 3), but with a more pronounced costal spine at the tip; in the proportionately longer aedeagus, the cornutus is of similar form but slighter than in *tabora*.

Holotype: ♂, (prep. 1133), SW. Iran, Fars, Pireh-Zan, *c.* 7000 ft. (*c.* 2100 m.), 1-ix-40, EW. (in coll. m.)

Allotype: ♀, (prep. 1133), SW. Iran, Fars, Kazerun, *c.* 3000 ft. (*c.* 900 m.), 4-x-50.

Paratypes: 1 ♂ and 7 ♀♀, same data as holotype; also Fars, Shiraz, 5000-6000 ft. (*c.* 1500-1800 m.), 18-ix-40, and 30-ix & 1-x-50, EW. (in coll. m.).

This species inhabits hilly steppe and dry mountain sides, whether deforested or wooded, the same is true of its relative *tabora* Stgr. (Plate I, Fig. 2). Both are univoltine autumnal in flight, as is the case with the closely related *marginelota* which inhabits Middle Heights of the Lebanon. Probably this ecology and phenology characterises the whole genus, which has previously been treated as *Cryphia* (*Bryophila*) and *Oedibrya* Hamps. [see Boursin, 1961, *Beitr. naturk. SW-Deutsch.* **19** (3)].

Subfamily QUADRIFINAE

(?) Cryphia polyphaenoides sp. nov. (Plate I, Fig. 6)

From all *Cryphia* (*Bryophila*) and related genera easily distinguishable by its coloration: pale grey forewing and dull orange hindwing.

Head and thorax, with neatly adpressed slate-grey, white-edged scales, giving it, under magnification, a smoother aspect than the foregoing and most other *Cryphia* species. Palps otherwise similar. Frons, bulging in a slightly more rectangular form.

♀ antenna, ciliate.

Forewing, comparatively wide and square, but in proportion to the hindwing, similar to other *Cryphia*; pale slate-grey, with faint darker yellowish grey markings mainly in the cell between the stigmata, before the submarginal line, and on the termen. Reniform and orbicular stigmata, vaguely paler; submarginal line, pale and wavy; termen, a series of faint dark spots; other markings, obsolete; fringes grey.

Hindwing, dull orange-brown, infuscated submarginally; fringes dull yellow, chequered with grey.

Undersides, much paler, the forewing being more yellowish than on its upper side and thus less distinct from the hindwing in general colouring.

Span: 30 mm.

In the absence of a male there must remain some doubt whether the generic attribution to *Cryphia* is right.

Holotype: ♀, Bahrain, Adari Pool Gardens, 23-ii-60, EW (in coll. m.)

This appears to be an oasis moth. Lichens and algae (on which *Cryphia* feed) are found on desert vegetation in Bahrain, despite the low rainfall, doubtless because of the heavy dews and humidity; but no *Cryphia* species has been taken in the desert there.

Porphyrinia rushi sp. nov. (Plate II, Figs. 16, 24)

A third species in the *P. leucota* Hamps.-*nives* Brandt group, differing from them in habitat and phenology; less white than *leucota*, smaller and with a more crooked but less oblique median-band than *nives*. Probably the Sinai (U.A.R.) form in this group really belongs to *rushi*, not *nives*.

Antenna of ♂, ciliated, with cilia about as long as breadth of shaft; of ♀, simple.

Palp, second joint with pink-brown adpressed scales; third joint, short.

Tongue, fully developed.

Thorax, grey; abdomen, whitish grey.

Forewing whitish marked with slate-grey and orange-brown, or (ab. *frigida* ab. nov.) deep olive-brown. The latter form seems to be due to wet cool weather, and lacks the more normal orange-brown tints; the one example of it which I possess is strongly contrasted, with white and dark grey forewing, rather like *nives*, except that the distal edge of the median band has three irregularly prominent angles; in *nives* these angles are all equally prominent, but in *rushi* the second, on the cell, exceeds the others, thus giving the new species a less straight median band. This band is at right angles to the hind-margin, whereas in *nives* it is oblique. In less strongly marked forms than ab. *frigida* the differences in the median band are not always distinct but in all forms a further criterion is the course of the submarginal line, which in *nives* is acutely inward-angled on nervure 2 only, but in *rushi* is more roundly-indented on both nervures 2 and 3.

There are sometimes two black cell-spots representing the orbicular and reniform stigmata of the forewing; the latter spot is placed distally of the median band.

The basal area of the forewing is mixed with white, grey, and usually orange. The ante-median fascia is grey, suffuse, zigzag, followed immediately by the broad cental band which in the normal form is orange-brown. Between it and the wavy, not zigzag, mauve-grey post-median fascia, is a suffused pale slate-grey area; beyond this fascia is an area, wide at the costa, and narrower at the hind margin, orange-brown, or, in ab. *frigida*, deep olive-brown, bordered distally by a wavy white submarginal line, against which, in the bays formed by the mauve-grey submarginal area, are placed a few fine black spots, variable in number. The grey submarginal area reaches the costa and the hind-margin. Termen, variable, a rather faint pale line, sometimes with a clear wavy brown proximal edge, and always with grey distal spots on the fringe at the nervures, usually producing a grey-chequered fringe with a fine white distal line. Fringe, pale brown distally.

Hindwing, pale whitish, with an almost obsolete grey median band and two parallel distal bands, sharply angled on nervure 2. In ab. *frigida* the cell is infuscated, also nervures 1 and 2 basad. Termen, fine, grey. Fringe, grey, with a white basal line.

Underside, dirty whitish.

Span: 17-22 mm.

Genitalia, ♂, (Plate III, Fig. 5). With uncus and aedeagus as in *leucota* and *nives*. The three species differ in the development of the harpe, which consists of a tongue-like sclerotised projection above a setose angular process, and is widest and longest in *nives*, narrower and shorter but still projecting beyond the process in *leucota*, shorter and hardly projecting in *rushi*.

♀, posterior, apophyses comparatively long and slender, anterior, comparatively short and spatulate; ostium, weak; ductus, chitined above the twist; bursa, with a small field of internal spinules in the central-upper (distal) part, extending over less than half the circumference, (Plate III, Fig. 6)

Holotype: ♂, (Prep. 1064) Bahrain, nr. Amar, southern desert, 27-ii-60, DR. (in coll. EW).

Allotype: ♀, Bahrain, same locality, 24-iv-60 (EW).

Ab. *frigida* type: ♂, Bahrain, Sakhir desert, 14-iii-61 (EW). (Plate II, Fig. 24)

Typical paratypes: ♀, same data as holotype, DR, in BM.

Saudi Arabia, Eastern Province, ♀ (Prep. WM. 139) Hofuf, 25-ii-57. T., and ♂, ditto, 15-iii-57, T. (ZM).

In Bahrain this species is a univoltine vernal species inhabiting limestone desert with a slight sand cover in places, the vgetation consisting of grasses and a rather varied association (*Lycietum-Helianthemetum*).

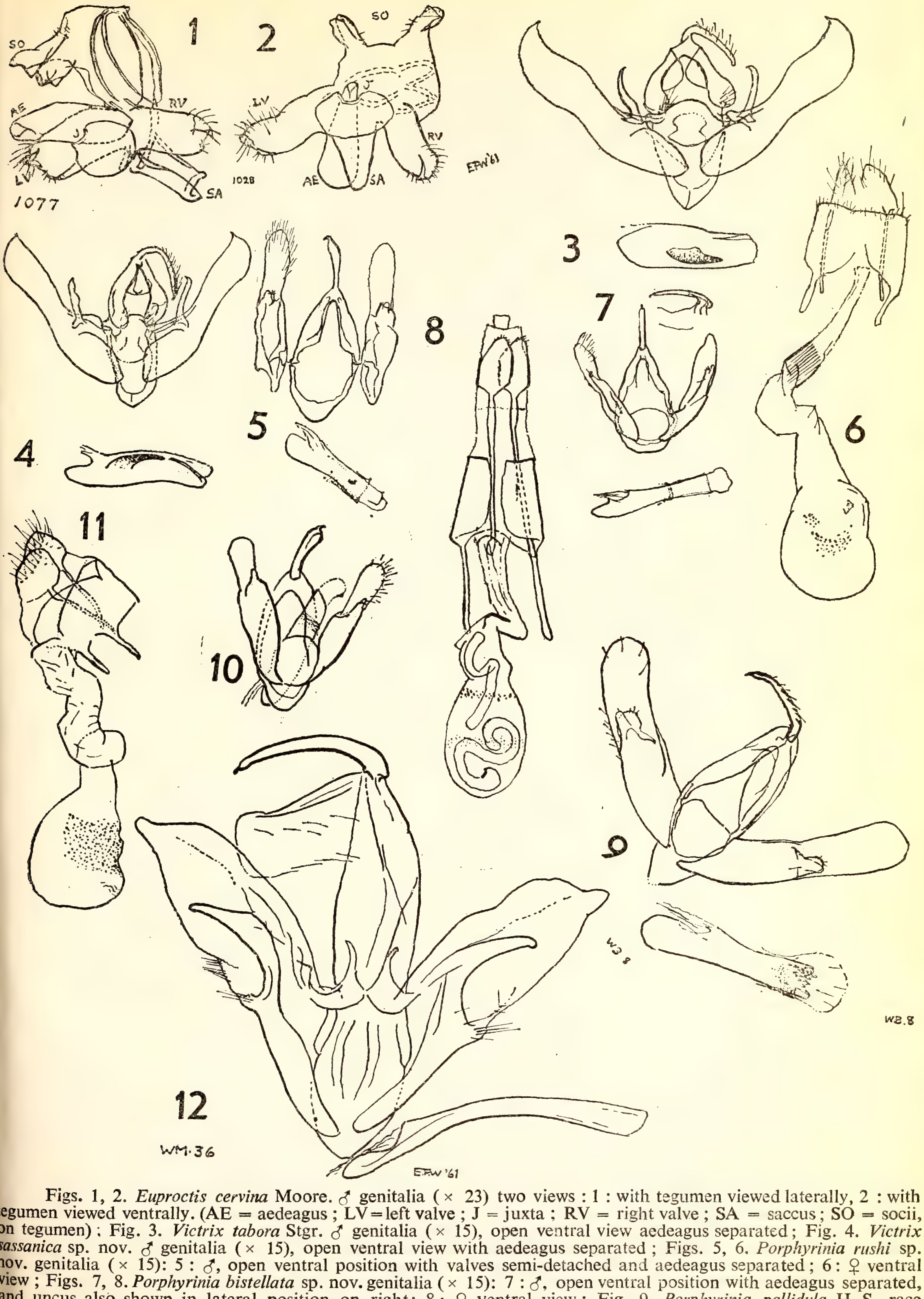
Porphyrinia bistellata sp. nov. (Plate II, Figs. 17, 18)

Antenna, of ♂, strongly ciliated; of ♀, sparsely ciliated.

Tongue, absent or vestigial.

Thorax, grey; abdomen, light grey.

Forewing, with straight costa, fairly pointed apex, and semi-circular outer margin, paler or darker slate-grey, occasionally streaked narrowly



Figs. 1, 2. *Euproctis cervina* Moore. ♂ genitalia (× 23) two views : 1 : with tegumen viewed laterally, 2 : with tegumen viewed ventrally. (AE = aedeagus ; LV = left valve ; J = juxta ; RV = right valve ; SA = saccus ; SO = socii, on tegumen) ; Fig. 3. *Victrix tabora* Stgr. ♂ genitalia (× 15), open ventral view aedeagus separated ; Fig. 4. *Victrix sassanica* sp. nov. ♂ genitalia (× 15), open ventral view with aedeagus separated ; Figs. 5, 6. *Porphyrinia rushi* sp. nov. genitalia (× 15): 5 : ♂, open ventral position with valves semi-detached and aedeagus separated ; 6 : ♀ ventral view ; Figs. 7, 8. *Porphyrinia bistellata* sp. nov. genitalia (× 15): 7 : ♂, open ventral position with aedeagus separated, and uncus also shown in lateral position on right; 8 : ♀ ventral view ; Fig. 9. *Porphyrinia pallidula* H.-S. race *cypriaca* Stgr. Type ♂ genitalia (× 23), open ventral position with aedeagus separated ; Figs. 10, 11. *Porphyrinia bulla* Swin. genitalia (× 15): 10 : ♂, ventral view, left valve shut, right valve open ; 11 : ♀, ventral view; Fig. 12. *Catocala timur* B.-H. *richteri* subsp. nov. ♂ genitalia (× 15), ventral open position, with aedeagus separated.

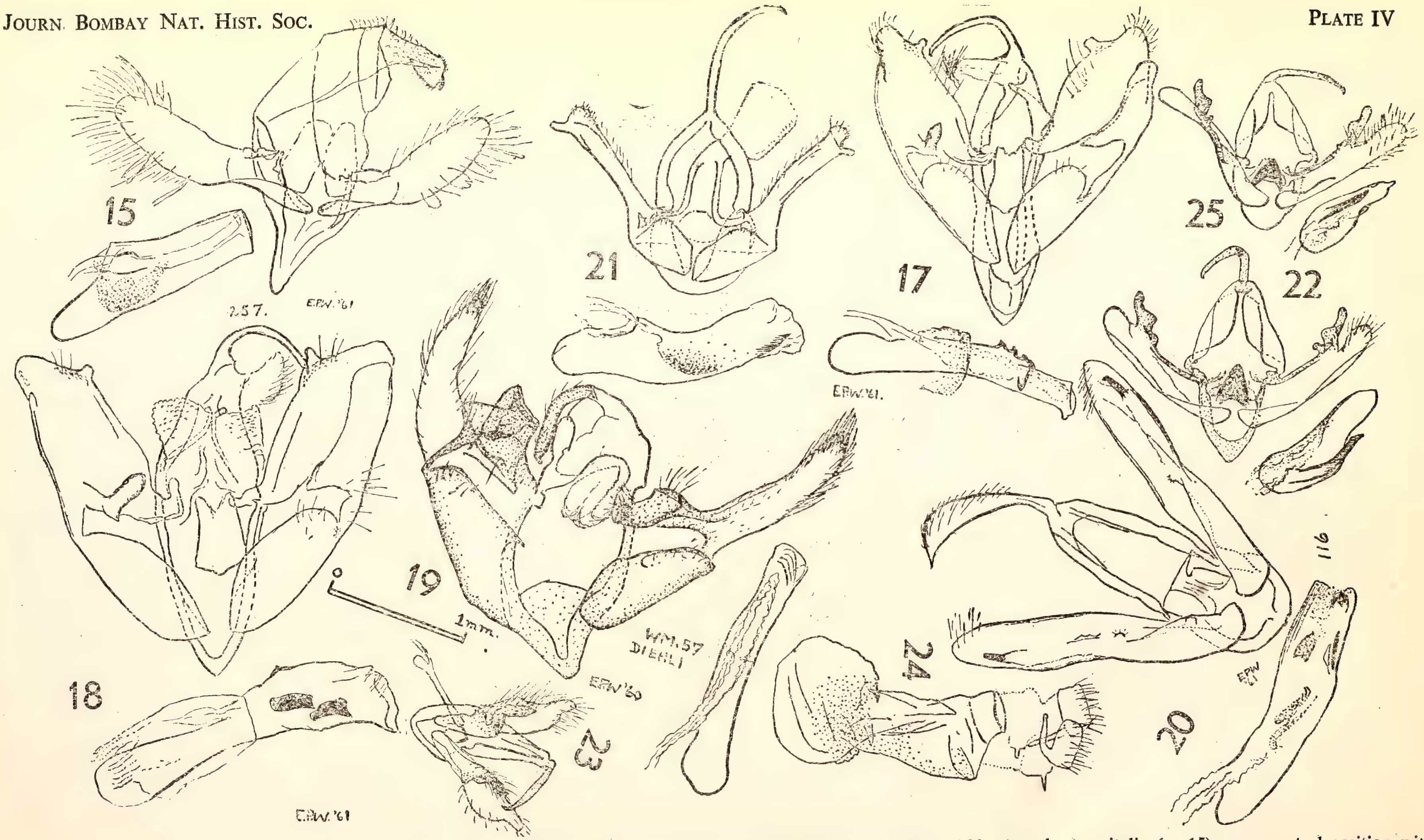


Fig. 15. *Anumeta arabiae* sp. nov. ♂ genitalia (× 23), open ventral position with aedeagus separated. Figs. 17-18. *Armada* ♂ genitalia (× 15), open ventral position with aedeagus separated: 17 : *fletcheri* sp. nov. 18 : *dentata* Stgr. (Type). Fig. 19. *Riadhia diehli* gen. nov., sp. nov. ♂ genitalia (× 23), open ventral position, with aedeagus separated, Fig. 20. *Lygephila fereidun* sp. nov. ♂ genitalia (× 15), open ventral position with aedeagus separated; Fig. 21. *Antarchaea pyralomima* sp. nov. ♂ genitalia (× 23), ventral open position with aedeagus separated; Figs. 22-25. Hypeninae genitalia (× 15) : 22 : *Rhynchodontodes orientis* (Brandt) *richteri* subsp. nov. ♂, ventral open position with aedeagus separated; 23 : *Hypenodes* (*Schrankia*) *balneorum* Alph. ♂, ventral view, with left valve shut, right valve open; 24 : *Rhynchodontodes orientis* (Brandt) *richteri* subsp. nov.

with paler colouring along the costa; in one exceptionally light example (from Hofuf) a light brown tint invades the whole wing replacing the grey, but usually only the submarginal area is light tawny brown. Termen, a brown line, sometimes black-spotted on the nervures, with a white distal edge at the base of the fringe, which is grey-brown. Reniform stigma, represented by two diffuse, whitish star-like points, placed one above the other, and often united. A black oblique apical streak is continued in an almost straight line to near the tornus, sometimes as an interrupted series of black intra-neural spots; even in the pale brown form, this oblique streak is indicated in darker brown.

Hindwing, paler costad and basad, dull grey; fringe, slightly paler.

Underside, pale grey with a brassy metallic sheen, more yellowish on the costa; apex and fringe, usually darker brown.

Span: 14-25 mm. (but nine out of ten are between 19-22 mm.).

Genitalia, ♂ (Plate III, Fig. 7): The uncus, in ventral view appears not to taper, having a spine-like tip protruding from an apparently roundly truncated end; but in profile or lateral view (Fig. 7 top right) this character is less pronounced. The aedeagus is without even the smallest cornutus. ♀ (Plate III, Fig. 8): bursa, with two narrow bands of internal spinules, the upper (near the distal end) being narrower and with stronger spinules; the lower (just below the centre) slightly wider, less dense and with weaker spinules.

Holotype: ♂, (Prep. 1069) Bahrain, nr. Amar, southern desert, 21-iii-60, DR. (in coll. EW).

Allotype: ♀, and three paratypes, both sexes, same data, in coll. DR. in BM. & in coll. EW.

Other paratypes: 1 example, Arabia, Marrat, 6-iii-35, P. (BM.); 3 examples, (2 ♂, 1 ♀) Saudi Arabia, Eastern Province; Hofuf, 30-iii-57, T, and Abqaiq, (Prep. WM. 105) 24-iv-57, T. (ZM.). Also 12 examples, same place as holotype, 5-iv-61, and 1 ♀, 5-x-61 (EW), in coll. EW.

This new species may be placed between *pallidula* H.-S. and the African species *arenostrota* Hamps. and *penicillata* Hamps. From all of these it can be superficially distinguished by the two whitish points which none of them possess. From the *pallidula* forms, the male uncus, and the narrow central band of minute spines on the female bursa of *pallidula* subsp. *khalifa* (see below) are structural criteria. *P. pallidula khalifa* actually flies with *bistellata* in Bahrain but is commoner, less local, and has more generations; as well as lacking the two white points, it lacks the oblique apical streak of *bistellata. P. penicillata* may also be distinguished by the blackening of its subcostal field and median area; *P. arenostrota* is also distinguished by a pale suffused tawny streak along its forewing median nervure, spreading as far as the submarginal area.

Porphyrinia pallidula H.-S. subsp. **khalifa** subsp. nov. (Plate II, Figs. 19-22)

From the northern subspecies, comprising the typical *pallidula* H.-S. (Transcaspia) and also the forms *cypriaca* Stgr., (Cyprus, S. Turkey, and Lebanon) (the ♂ genitalia of a type of which are shown in Plate III, Figure 9) and *griseola* Ersch. (Central Asian Mountains), I now distinguish a southern subspecies inhabiting Arabia, Bahrain and the lower elevations of south Persia. I no longer consider the latter group of forms representative of typical *pallidula* H.-S. and have renounced my intention of selecting a lectotype from among them. Instead, I propose to describe them under a new name on morphological and distributional grounds.

The new subspecies is smaller than the northern subspecies on the average; the male vesica is less spiculated; its forewing termen is usually an interrupted line. The colouring varies greatly with season and locality. It seems already possible to distinguish two races belonging to the subspecies, and perhaps when a series from more localities collected all the year round is obtained, it may be possible to distinguish more than two. At present fewer examples are available from Saudi Arabia and S. Iran than from Bahrain, which is the typical locality of the new subspecies.

Race *khalifa:* varies from whitish through pale brown and orange-brown to dark slate-grey, the darker forms appearing in winter and spring, the paler in summer and autumn, on the whole. In the darker, the termen remains a clear white line with a dark grey proximal edge interrupted at the nervures; in the paler, the proximal edge consists of a series of light brown spots. The markings are very variable; two dark cell-spots are usually marked, the reniform stigma being represented by a larger circular spot than the fine point-like orbicular; the post-median fascia is often absent even in the darker forms, and is always less clear than these two points; when marked it is outlined in smoky grey and curves round the cell and thence runs straight to about the middle of the hind-margin.

Hindwing: dirty grey-brown, rarely paler.

Span: between 12 mm. and 18 mm., the largest forms usually appearing in winter and early spring and having darker colouring.

Holotype: ♂, (Prep. 1024) Bahrain (desert), 26-ix-59.

Allotype: ♀, Bahrain same date. (Plate II, Fig. 20)

Paratypes: ♂ (Prep. 1071) Bahrain (oasis), 28-ix-59; 2 other examples, same data as holotype; 2 examples, Bahrain (desert), 5-xii-59; 1 ♂, Bahrain, Rifaa, (desert), 1-i-60; 4 examples. Bahrain, Jurdeh (desert) 19-ii-60 (one is shown in Plate II, Fig. 19); 2 examples, ditto, 17-ix-60; 3 examples, ditto, 19-ii-61; all the above were taken by myself and are in coll. m. except two which have been presented to the Zoological Museum, Humbold University, Berlin; other paratypes with similar data are in coll. m., including ♂, Prep. 1022, Plate II, Fig. 12 in my previous article (1961) and again in this article, Plate II, Fig. 21; others, DR, from Bahrain, are in BM.

Race **nejdi** f. nova

This form is slightly larger than typical *khalifa* and is more whitish and pale brown, with a tendency to grey streaking along the cell, and no trace of post-median fascia; the orbicular stigma is not marked by any black point, but the reniform is indicated by a greyish streaky cloud. The hindwing is also paler than the average typical. An oblique apical shade on the forewing is usually defined in light brown with a whitish proximal streak. The termen is light brown.

The hardly spiculated vesica makes this form belong to the Bahrain subspecies rather than the more northerly.

Span: 19-22 mm.

Holotype: ♂, Saudi Arabia, Riadh, 13-ii-60, (ED), (Prep. WM. 79), in coll. ZM.

Paratype: ♂, ditto (Prep. WM. 104) ditto.

Paratype: ♂, ditto, ix-58.

The following may belong to this race or to a third; at present the available material is insufficient for one to be sure: 1 ♂, Iran, Khuzistan, 18 km. north of Shadegan, Jarrahi River Bank district, 28-iii; 6-iv-56, R.S., in coll. S.M. (Plate II, Fig. 22) (Prep. WM. 74).

For genitalia of both sexes of this new subspecies of *pallidula* H.-S. see Figs. 14 & 18 of my preceding article; also see Plate III, Fig. 9 for Cyprus race.

As regards **griseola** Ersch., illustrated in my preceding article, I do not consider it specifically separable from *pallidula* H.-S., despite Erschoff's opinion given in his description; and indeed most European museums have had difficulty in distinguishing these two. As I explained in the previous article, for years in the British Museum the *pallidula* forms were correctly named but under *griseola* were placed a series of *conistrota* Hamps. forms; this error however has now been corrected. In Russia, it is clear, from specimens sent recently to the British Museum as '*griseola*' emanating from Transcaspia, that the name *griseola* is there applied to a species also common in the mountains of Iran (Persia) from Elburz to North Fars; its forewing varies from yellowish unmarked to greyer with post-median fascia marked. My conclusion is that *griseola* Ersch., as originally described from a single grey specimen from the high mountains of Alai (Kokand) and another specimen from N. Persia (Astrabad), is possibly a good race of *pallidula* in Alai but elsewhere in the range of this species is a frequent aberration analogous to the darker forms of Bahrain. I have been informed by Dr. Alberti that the types of *pallidula* H.-S. (described from Syr-Daria Trans-Caspia) are no longer existent, either in Berlin or Halle; and I therefore select as lectotype of *pallidula* H.-S. the yellowish example from Nukus, Transcaspia, sent as '*griseola*' by the Leningrad Museum to the British Museum, London. This selection stabilises the two names as a conspecific unit.

Porphyrinia bulla Swin. (= **P. tomentalis** Rebel syn. nov.) (Plate II, Fig. 25)

The other common *Porphyrinia* species of the desert of Bahrain may be mentioned here, as it occurs elsewhere and its oldest name has been overlooked. It is a true desert moth but sometimes also flies in palm-gardens (oasis). It is widely distributed, as it ranges from near Karachi, whence Swinhoe described it, at least to Egypt, whence Rebel posthumously described it in 1948. The male genitalia were shown in Fig. 39 of the LEPIDOPTERA OF EGYPT (1948, EW); the uncus is characteristic and there are one or two linked minute cornuti in the aedeagus. A larger figure may be useful, and is given herewith (Plate III, Fig. 10); two convergent dorsal ridges on the uncus are responsible for its club-like aspect; their presence is not always easy to discern unless several preparations are made. Swinhoe's type has become dingy with age; however it exists in the BM., and Mr. Fletcher has kindly made a preparation of its genitalia, which are recognisable and agree with those of the Bahraini and Egyptian forms. The ♀ genitalia are characterised by a wide field of small spicules inside the bursa; this field does not however extend round

Page 618, line 17: for ‘lectotype’, please read ‘neotype’.

the whole circumference; the posterior apophyses also are more than twice as long as the anterior (see Plate III, Fig. 11). The moth varies greatly in size and facies; a few summer and autumn forms may have plain glossy white or yellow forewings; but most commonly, and especially at other seasons, slightly striated forms, of a powdery or sandy appearance are to be taken; these have one or two black spots in the forewing cell usually and sometimes are peppered submarginally with black or grey scales between the nervures. The termen is never defined and there are no cross-lines. Two examples from Riadh (ED, ZM): ♂, 3-ii-58, Prep. WM. 86 and ♀, 11-iii-58 (Prep. WM. 107) have been taken and show that this moth inhabits Saudi Arabia, as indeed was to be expected once its synonymy with *tomentalis* Rebel from Egypt was established.

Catocala timur B. H. **richteri** subsp. nov. (Plate I, Fig. 5)

The forewing agrees perfectly with British Museum's series of *timur* Bang-Haas (Transcaucasia), but the hindwing is paler pink, with an orange tint, and not (as in typical *timur*) pink as in *C. puerpera* hindwing; another difference in the hindwing is that the apical pale patch (outer edge of the black border) is more pronounced; in fact the hindwing is almost exactly the same as in *C. neglecta* Staud. but the forewing is quite different from that.

The genitalia of the male are shown in Plate III, Fig. 12.

Holotype: ♂, (Prep. WM. 36), allotype ♀, and paratypes 23 ♂♂ and 3 ♀♀, S. Iran. Iranshahr, 800 m., 12-iii – 30-iv-54, R. (in coll. S.M., ZM, EW).

Anumeta asiatica sp. nov. (Plate I, Figs. 8, 9, 13, 14)

This large and handsome form is closely related to *spatzi* Roths. 1915 and *major* Roths. 1913 and perhaps is no more than a subspecies of one of them, if in fact they are distinct. Owing to uncertainty on this point, I introduce the new form as a separate species, provisionally.

The type of *major* is a ♀ and there are no topo-typical ♂♂ in the British Museum collections. The type of *spatzi* is a ♂; there is in the Tring Museum a ♀ attributed to *spatzi*; this proves to have similar genitalia to the *major* type, according to Mr. D. S. Fletcher, who kindly investigated the typical material.

The Arabian-Iranian form is very variable; more material of it is available than was ever taken either of *spatzi* or *major*. It resembles *spatzi* in markings, but most examples resemble *major* in size and colour. The markings which appear to me, from my own inspection of the types, to distinguish Rothschild's two forms from one another are:

	spatzi & *asiatica*	*major*
forewing, post-median fascia	bent distally tight round cell	more gently curved distally and inwards to nervure 2
hindwing spot	compact and almost circular	more diffuse, less circular

The differences of thorax-colouring given in Draudt-Seitz do not enable one to consider the Asiatic form as one or the other, but the same author's statement that the black hindwing spot is free in *major* but in *spatzi* merges with the brown band, would indicate that *asiatica* belongs to *spatzi*.

Antenna: ♂, with cilia shorter than breadth of antenna; ♀, simple.

The forewing ground colour is white widely over-laid with yellow-brown and purple-brown scales, less widely with black. The post-median fascia is not always clearly defined. The nervures may be defined with black and white scales, and a series of intra-neural black wedges is usually present on the termen. Fringes, brown. There is a very conspicuous wedge-shaped black basal streak below the median nervure, and sometimes the median area between this and the costa is filled with black. The ante-median fascia is only clear on the costa; usually the costa is sprinkled with white between the black spots marking the post-median fascia, and the apex.

The hindwing is white, but in the ♀ this colour only appears as a 'window', narrow at the anal angle and wide at the middle of the outer margin, on either side of the black spot between the submarginal band and the termen; the rest of the wing in that sex is brown-suffused; in the ♂ the white colour also appears proximally of the wide brown submarginal band to a variable extent. Termen, wavy, brown. Fringes, white in both sexes.

Span: ♂♂, 40-45 mm.; ♀♀, 40 mm.

Male genitalia, (see Text-fig. 13): uncus, stout, very slightly arched, of uniform thickness from base to the truncate end from the middle of which projects the typical down-pointed fine tip; valve, without neck, of more or less uniform thickness, with evenly-rounded end; costa of valve, studded with many enlarged setae; near the ventral border on the inner side, a setose ridge parallel to that border runs to the valve tip. Saccus, short. Aedeagus, sclerotised, cylindrical, the *ductus seminis* entering near the proximal end which is subrectangular; of uniform thickness for 2/3 of its length, then narrower for the distal 1/3. Vesica, with a chitinous plate, usually placed obliquely, shorter than diameter of the aedeagus at its broadest.

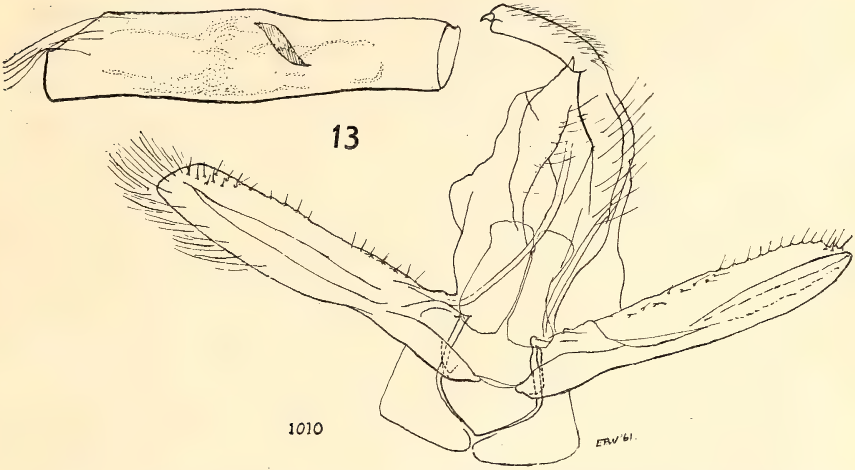


Fig. 13. *Anumeta asiatica* sp. nov. ♂ genitalia (× 15), open ventral position, with aedeagus separated

Female genitalia: anterior and posterior apophyses of about same length; ostium, not sclerotised; ductus, sclerotised and widening from ostium to top of bursa, whence *ductus seminis* leads off; bursa, long, sac-like, lacking internal spines, but uniformly stippled or roughened.

Ovum: To the abdomen of one of the ♀ paratypes adhere a number of ova, due to injury; they are bun-shaped (i.e., circular in horizontal section, and semi-circular in vertical section) with strong sculpture in the form of lines convergent apicad.

Holotype: ♂, S. Iran, Khuzistan, Ahwaz, *c.* 400 ft., 26-v-38, EW, in coll. m.

Allotype: ♀, Arabia, Nejd, Riadh, xi-58, ED, in coll. Muenchen.

Paratypes: 2 ♂♂, (Prep. 1010) Kuwait, desert, 2-v-43, EW; also one ♀, same data as holotype; all in coll. m.

5 ♂♂, 4 ♀♀, Arabia, Nejd, Riadh, same date as allotype, or 2-14-vii-58, ED, in coll. Muenchen.

1 ♀, (Prep. 1010 L) same data, in coll. m.

2 ♂♂, 2 ♀♀, SE. Iran, Iranshahr, iv-54, R. (in coll. Stuttgart)

Anumeta eberti Wilts. **zaza** subsp. nov.

Of this large species, described and illustrated in the preceding article from the deserts of southern Afghanistan, a more variable form inhabits the most inhospitable wastes of southern Arabia. It resembles the typical in size and pattern elements, also in genitalia (see Text-fig. 14), but the colouring is variable, with apparent sexual dimorphism. The ♀♀ have the forewing suffused completely with sienna-brown; the ♂♂ on the other hand usually have a whitish suffusion beyond the post-median fascia against which the nervures appear darker; the post-median fascia and submarginal line are finely edged distally with paler scales and with a series of isolated white points.

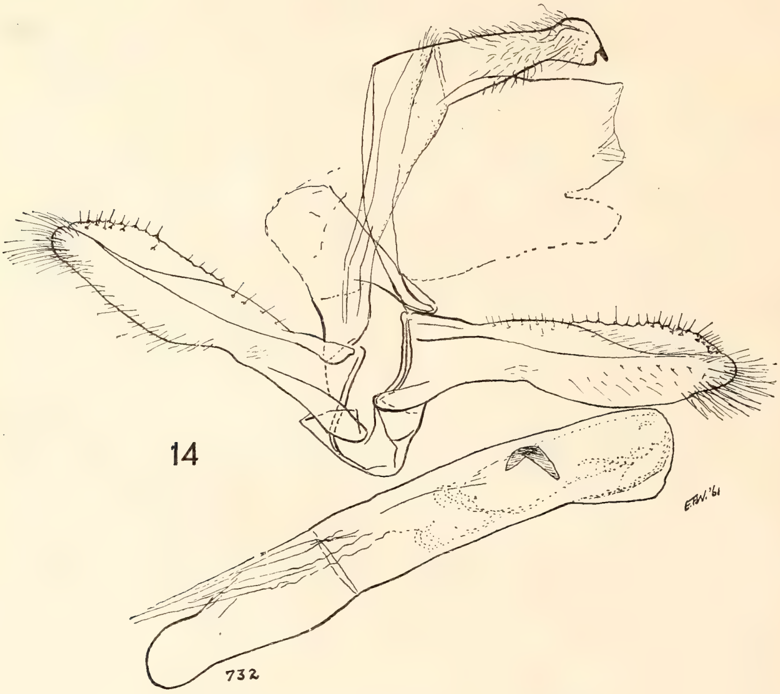


Fig. 14. *Anumeta eberti* Wilts. *zaza* subsp. nov. ♂ genitalia (× 15), ventral open position, with aedeagus separated

Holotype: ♂, (Prep. 732) South Arabia, Sawada, 12-ii-52 (Leg. G. Popov) in coll. m. (EW).

Allotype: ♀, (Prep. BM. 2976) South Arabia, Rub' al Khali, waterless part, Hadhat Hawaya, 28-ii-33, P. (BM).

Paratypes: 1 example, Hadramaut, 17.05 N., 43.30 E., Arq Zaza, ii-52 (Leg. G. Popov) and 3 examples, same as holotype, in coll. m. (EW). Also 5 examples, same as allotype, P. (BM).

Anumeta arabiae sp. nov. (Plate I, Figs. 10, 11)

This form was first taken at Hail in 1944 by A.W. and subsequently in the Dahana in 1946 by others of the Middle East Anti-locust Units under Dr. B. P. Uvarov. Examples of this first series were deposited in the British Museum and coll. m. (EW), and I reported in my article on Arabian lepidoptera of 1952 the species under the name *dentistrigata* Stgr. a central Asian species, as its genitalia (Prep. 257) did not seem to differ from Oscar John's figure of the typical *dentistrigata*.

I now feel it should be considered as a distinct species from Staudinger's; it is less robust, and more obscurely marked on the whole than the typical *dentistrigata* or than its dull, pale yellowish race, subsp. *languida* Warren. The long series (ED) shows it is very variable in colouring.

The male is the larger sex. In colour the sexes are not characterised from one another. The ♂ antenna is profusely ciliated (length of cilia twice breadth of shaft), the ♀ antenna barely setose.

Thorax and forewing, yellow-brown more or less suffused with white, black and fuscous scales. In some dull forms the general hue is dull yellow-brown slightly infused with darker grey; in these the forewing fasciae may be distinct but more often are obsolete. The black markings in some forms are concentrated to form costal spots, streaks in the cell, to delineate proximally the ante-median and post-median fasciae (which are often delineated distally with a pale edge), to darken the median area, particularly below the median nervure, to form a sub-marginal shade running from the apex in an irregularly wavy course towards the tornus, and to form a series of intra-neural terminal crescents; in the obscure forms where few of these markings stand out, black scales are scattered generally over the forewing. In some forms whitish or pale grey scales are concentrated along the cell and sub-costally almost to the apex, also to form four white costal spots beyond the post-median fascia; the median nervure in some forms is quite outstandingly pale.

Hindwing, whitish, more or less suffused with smoky brown sometimes on the disco-cellular (to form a crescent cell-spot), more often along the nervures and often also to form a variable submarginal band. Termen, brown, variable; in some forms an inner, finely wavy dark terminal line can be seen; in others only a series of dark intraneural spots. Fringes, whitish.

Underside whitish, usually only slightly sprinkled with grey and brown terminad; on both wings the cell-spot is sometimes indicated; termen of hindwing, sometimes marked as in forewing.

Span: ♂, 35-38 mm.; ♀, 31-35 mm.

Male genitalia (see Plate IV, Fig. 15): Proportionately small and characterised by several scent scales attached to each valve, some being remarkably broad. Uncus, short, slightly arched, stout with fine down-turned tip, slightly constricted in the centre, the tip projects from about the middle of the truncate end of the uncus; valve, with a more sclerotised basal neck, thereafter wider and of uniform thickness and less sclerotised, with regularly rounded end. The larger setae of the valves are not concentrated or numerous; two or three widely-spaced enlarged setae are placed along the middle of the inner surface of the valve in a row parallel to the costa; some others, slightly smaller, are on the ventral border. Sacculus, deep, tapering. Aedeagus, cylindrical but enlarged immediately distally of the entry of the *ductus seminis*.

Female genitalia: Posterior and anterior apophyses of about equal length. Ostium, membranous; ductus bursae sclerotised near ostium. Bursa, membranous, long-oval, without signum but with a central field of internal minute spines reaching to the bottom, anterior, end, but not extending over the whole circumference.

Holotype: ♂, (Prep. 257) Arabia, Nejd, Dahana, Awania, 19-ii-46 (McE) in coll. British Museum, London.

Allotype: ♀ central Arabia, Nejd, Riadh, xi-58, ED in coll. Muenchen.

Paratypes: 7 ♂♂ and 4 ♀♀, central Arabia, Nejd, Riadh, xi-57, i, & ii-58, ED, ZM; 1 ♂ & 1 ♀, same place and captor, 27-i and 10-iv-58, coll. mea. Also 2 ♂♂, same place and captor, summer 1958, 700 m., and 1 ♂ Eastern Arabia, Hofuf, 25-ii-57, T; ZM and 2 ♀♀, central Arabia, Riadh, 23-iii-58, & ix-58, ED, ZM. Other paratypes in coll. mea. or BM are labelled: Arabia, Hail, 17-i-44, ARW; Hinna, xi-46, McE.: and Dahana, ii-46, DVF & SG.

Anumeta atrosignata Walker (Plate I, Fig. 15 ; Text-fig. 16)

I take this opportunity to illustrate this species, which some authors, following Warren-Seitz, have wrongly regarded as synonymous with *spilota* Ersch. and *harterti* Roths. These last two are indeed very close together but *atrosignata* is not like them at all but more resembles *A. sabulosa* Roths., and *arenosa* Brandt without being identical with them.

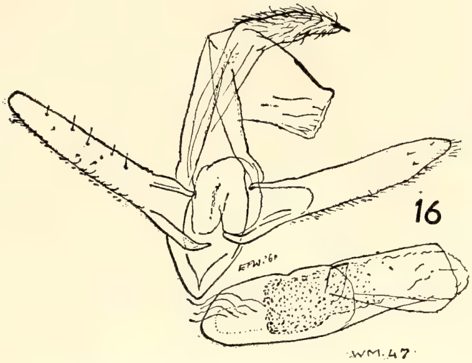


Fig. 16. *Anumeta atrosignata* Walk. ♂ genitalia (× 15), open ventral position, with aedeagus separated

Walker's type of *atrosignata* from India still exists in the British Museum which also possesses a similar example from Arabia. Now a further Arabian example has come to hand, taken at Riadh, xi-58, ED, Prep. WM. 47, and is here illustrated.

A. sabulosa Roths., a more strongly marked and darker species, was also taken at Riadh, 21-vii-58, ED, ZM, (Plate I, Fig. 12).

A revised list, therefore, of the *Anumeta* species of Arabia is as follows:

A. asiatica Wilts.
A. eberti zaza Wilts.
A. arabiae Wilts.
A. atrosignata Walker
A. sabulosa Roths.
A. cestis Men., Nejd & Jebel Shammar, ii-iii-46, DVF & SG, in coll. mea.
A. straminea B.-H., Riadh, xi & xii-59 & 1-i-60, ED, ZM.
A. surcoufi Dumont, Riadh, 28-iv-59, ED, ZM, Hadramaut, leg. Popov, coll. mea.
A. fractistrigata Alph., Nejd & Jebel Shammar, ii-iii. 46, DVF, & SG, coll. mea.
A. spilota Ersch. (? f. **harterti** Roths.), Riadh 18-iii-58, ED, ZM; Abqaiq, 6-iv-57, T, ZM; Trucial Oman & Bahrain, EPW.

It is not yet possible to give a final opinion on the status of these last two names.

Armada fletcheri sp. nov. (Plate I, Fig. 3)

Smaller, more uniformly rosy-brown than the generotype *Armada dentata* Stgr., to which its male genitalia show it is closely related. Only one example is known, and the forewing of this lacks the infuscated median area, edged with black fasciae and boldly contrasting with the white area on either side, typical of *dentata,* but this criterion may be unreal and due to rubbing. Instead of two fasciae the hind margin shows traces only of a single cross band, apparently representing the median shade. Submarginal line, with black denticulations, much as in *dentata.* Hindwing, similar to *dentata,* but band and cell-spot weaker and more suffused. Until a better preserved example is taken the species must be distinguished principally by its genitalia.

Span: 21 mm.

Male genitalia: the characteristics which *dentata* and *fletcheri* have in common are a normal, slender uncus, with pointed tip; a juxta longer than wide, wider at its base, or proximal border which is obtusely angled; assymmetrical valves of more or less equal size, with a symmetrical small digitus on the costal extremity, and an assymmetrical thumb-shaped harpe (on left valve only); the extension of the sacculus is more developed on the right valve; an aedeagus with a distally sclerotised dorsal wall, the sclerotisation being differently developed in the two species but in both tending to form thorn-like excrescences. The new species differs in the form of the valve end (as illustrated in Plate IV, Figs. 17, 18), in the smaller harpe, and particularly in the aedeagus of which the dorsal sclerotisation forms three thorns close to the tip, while in *dentata* there is only one thorn, further back (i.e. more proximal) and less sharp; in *dentata* there are two internal chitinous plates of equal size, almost of cornutus-form, while in the new species there is nothing of the sort.

Holotype: ♂, SW. Iran, Khuzistan, Ahwaz, [*c.* 200 ft. (60 m.)], 21-x-38, EW.

A revision of the genus *Armada* and its related genera based on the characters of the male genitalia is in preparation and will, it is hoped, appear shortly. This group of genera may be called a tribe: Armadini, and the new genus described hereunder, *Riadhia,* may be placed in it close to *Armada* and *Asplenia* Hamps. Other genera in the tribe are: *Metoponrhis* Christ., *Acrobyla* Rebel, *Epharmottomena* Johns, and their synonyms.

Riadhia gen. nov.

Frons, with low crater-like round truncated prominence enclosing a vertical process, projecting slightly at its lower end in front of the crater-rim; this keel-like process is variable in form in individuals, and in some is hollowed internally into the form of a U, the base of which is most prominent; it never however approaches the blade-like form of the keel-process inside the truncated cone of such *Armada* species as *maritima* Brandt. The legs are as in *Armada*, with short forelegs and particularly short foretibia. The male genitalia are characteristic of the new genus: the valves are strongly dissymmetrical; there is no cucullus, the valve-tip consisting of a finger-like process thickly clad with adpressed bristles. The uncus is less tapering than in *Armada*, *Metoponrhis*, etc. There is no harpe or digitus on either valve, unless the hypertrophied process projecting from the left-valve costa can be considered a harpe; the sacculus of the left valve is also hypertrophied so that the whole apparatus is twisted; the aedeagus is relatively simple, without internal cornuti or external sclerotisations. Nervulation, as in *Armada dentata* Stgr.

Type: *Riadhia diehli* sp. nov. (below).

Riadhia diehli sp. nov. (Plate II, Figs. 23, 27)

Frons, with a prominence as described above partly covered with white scales and hair.

♂ antenna, missing.

♀ antenna, simple.

Tongue, present, normal. Palp, fine, fairly short.

Thorax, white. Abdomen, yellowish white.

Forewing, white, faintly marked with pale brown, especially the reniform stigma and the submarginal area. Median area, sometimes shaded with pale brown below the cell. Orbicular stigma, sometimes clearly defined, a small brown spot; reniform stigma, fused with median shade. Sometimes a white ill-defined submarginal line can be seen, parallel to the termen, in the wide brown submarginal area; this area reaches the hindmargin not far from the tornus, but is wider at the costa, and leaves a characteristic clear white broad post-median stripe. Fringes, white.

Hindwing, white, with comparatively large pale brown cell-spot and wide pale brown submarginal border. Fringes, white.

Span: 16-19 mm.

Male genitalia, as described under genus above, and illustrated in Plate IV, Fig. 19.

Holotype: ♂, (Prep. WM. 57) (lacks left wing, all legs, and antennae), and allotype, ♀ (the legs of which are mounted on left side of slide, Prep. WM. 57) (lacks antenna): Saudi Arabia, Riadh, 18-vii-58, ED, ZM.

Paratypes: 2 ♂♂, 1 ♀, Saudi Arabia, Riadh, 1-15-vii-58 & 1-v-59, ED, ZM.

Lygephila fereidun sp. nov. (Plate I, Fig. 7)

The pale straw, faintly marked forewing and brown collar distinguish this species from all its congeners; its pattern comes closest to that of the Spanish species *glycyrhiza* Ramb., the genitalia of which, however, I have not yet been able to examine to see whether a real relationship exists.

Palp, pale buff.

Antenna, ♂, ciliated, with ciliations about as long as the breadth of the shaft.

Neck and collar, sienna-brown.

Thorax, abdomen, fore- and hindwings, all pale buff or dull straw, slightly more brown-tinged on the wings terminad. The only marking is the faint brown crescent-formed reniform stigma on the forewing. Vague traces of a light brown median shade appear below it.

Underside, similarly coloured but lacking the forewing stigma; however, the submarginal clouding of both wings is perhaps stronger than on the upperside, and the nervures are slightly infuscated costad and terminad.

Span: 42 mm.

Male genitalia: the thickened uncus and some other characters incline me to place this new species in a group with *lusoria* and remote from *craccae* L. The harpe, longer than that of *craccae*, is nevertheless shorter than that of *lusoria*. The vesica contains similar elements to those of *lusoria* but the proximal scobinated field is shorter and the five or six teeth on the distal chitinous lump are larger and more like cornuti than in *lusoria*. For exact details, see Plate IV, Fig. 20.

I feel obliged to mention that these and other *Lygephila* genitalia show a close relationship to those of the genera *Apopestes* and *Autophila*, transferred to the Trifinae by C. Boursin in 1940 (*Mitt. Muench. Ent. Ges.* **30**, Heft 2, p. 514). However as vein 5 from discocellular mid-way between 4 & 6 on hindwing is well defined, I do not propose that *Lygephila* should be similarly transferred.

Holotype: ♂, (Prep. 116), N. Iran, Elburz Mts. Lar Valley, *c.* 9000 ft. (*c.* 2700 m.), 5-13-vii-39 (EW).

(?) Antarchaea pyralomima sp. nov. (Plate II, Figs. 26, 28)

As the genitalia do not show marked affinity either to *Antarchaea viridaria* or *A.* (*Raparna*) *coniocephala*, this new species is introduced provisionally in this genus. It is a pale sandy species recalling, when well marked, a Pyraustine Pyralid moth. A more scantily marked example (the paratype) was for a time wrongly placed among Sterrhine Geometrids. The neuration is typical of Noctuidae-Quadrifinae.

♂ antenna, strongly ciliated; tongue, developed.

Frons, smooth, slightly bulging.

Palp, with laterally compressed scales, prominently upturned.

Tibiae, not spined.; midtibia, with a pair of terminal spurs; hindtibia with two pairs of spurs.

Forewing, neuration: 3, 4, and 5 separate but close together from lower corner of cell; 6 from corner of areole; 7 and (8 and 9) from apical corner of areole, 8 and 9 on a long stalk; 10, 11, and 12 separate.

Hindwing: 3 and 4 on a short stalk, 5 from discocellular near their origin; discocellular, distinct but weak; 6 and 7 on a short stalk.

Forewing, pale biscuit, with brown stigmata sometimes clearly defined and fainter sandy brown streaky infusion along the nervures. Orbicular stigma, a finely outlined dark brown, pale-centred oval, or absent; reniform stigma, larger, less neat, with cloudy brown centre, sometimes obsolete. The post-median fascia is vaguely outlined in sandy brown without reaching either costa or hind margin; there are no other cross-lines, but the paratype shows traces of a brown oblique median shade. Termen, slightly undulate, with six dark brown spots at the nervures, absent in the paratype. Fringe, concolorous.

Hindwing, pale biscuit, slightly more yellow-brown terminad.

Undersides, uniformly pale biscuit, unmarked.

Span: 24-25 mm.

Male genitalia: Uncus, slender, normal, with spiny tip.

Valve, narrowest in centre, basal third at least double the thickness of the rest; valve-tip, bifurcate, the ventral arm being a downward-pointing pollex, the costal portion more rounded, membranous and slightly setose. Juxta, weak, simple. Aedeagus, fairly thick, cylindrical, slightly up-curved, with a small ventral-distal sclerotisation. Vesica, finely scobinated proximally, without any cornutus. (Illustrated in Plate IV, Fig. 21.)

Holotype (Prep. WM. 106): ♂. Saudi Arabia, El Riadh, 23-ii-58 (ED) ZM.

Paratype (Prep. WM. 140): ♂, Saudi Arabia, El Riadh, 4-iii-56 (ED) ZM.

Rhynchodontodes orientis (Brandt) (nov. comb.)

(*Hypenodes orientis* Brandt, 1938)

Rhynchodontodes orientis richteri subsp. nov. (Plate II, Fig. 29)

After examining the type of *Hypenodes orientis* Brandt from Tchurum, Fars, I find it closely related to *Rhynchodontodes sagittalis* Rebel from upper Egypt, and not at all closely related to *Schrankia* (=*Hypenodes*) species such as *costaestrigalis* and *balneorum* Alph. I illustrate the male genitalia of the latter (Plate IV, Fig. 23) and of the *orientis* Brandt holotype (Plate IV, Fig. 22).

Brandt's original description was also rather misleading in describing the palp as 'quite short'; 'shorter than in most *Rhynchodontodes* species' would be more correct.

In Makran (S. Iran) a race occurs which I here distinguish by the name of its captor, Herr Richter.

The median area is less brown and less separated from the rest of the forewing's grey ground-colour; there is a white diffuse lunule distally edging the blackish crescent-formed reniform stigma, which is absent in the holotype and the rest of the typical series illustrated by Brandt.

To compare with the male genitalia of the holotype of *orientis* I illustrate those of *richteri*; the only difference appears to be the proportionately smaller and finer dimensions of the former, but this may be individual rather than racial (Plate IV, Fig. 25).

I also illustrate the female genitalia (Plate IV, Fig. 24).

Holotype: ♀, S. Iran, Makran, Tiz near Putab, 25-iii-54, RS. (SM).

Allotype: ♂ (Prep. WM. 35) and 3 paratypes, ♀♀, S. Iran, Makran, Kahuran, near Putab, 25-iii-54, RS. (SM and coll. EW) (Prep. 1057).

Paratype: ♀, Baluchistan, Iranshahr, 800 m., 28 to 31-iii-54, RS. (SM).

A provisional arrangement of the genus *Rhynchodontodes* based on similarity of facies and development of aedeagus-probe would be as follows:

(i) With probe rudimentary: *antiqualis* Hubn., and *mardinalis* Stgr. (Genitalia illustrated in the preceding article in this series.)

(ii) With probe developed but not longer than aedeagus: *orientis* (Brandt) and probably *sagittalis* Reb. (whose genitalia I have not been able yet to examine).

(iii) With probe longer than aedeagus: *ravalis* Hubn., *ravulalis* Stgr., *revolutalis* Z. (=*syriacalis* Stgr., *eremialis* Walk., *centralis* Stgr.). (Genitalia illustrated in the preceding article.) I have not examined yet the other species in the genus.

REFERENCE

Wiltshire, E. P. (1952): Lepidoptera recently taken in Arabia. *Bull. Soc. Fouad I.*, Ent., **36**: 135-174.

On the occurrence of the Spiny Lobster, *Panulirus dasypus* (H. Milne-Edwards) in Bombay waters, with a note on the Systematics of Bombay Lobsters[1]

BY

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(*With one text-figure*)

During their investigations on the biology of spiny lobsters occurring in Bombay, the authors came across three species of lobsters. One of these was thought, at first, to be a colour variation of the Common Lobster *Panulirus polyphagus* (Herbst). Detailed examination, however, revealed that it was a different species, the most significant character for differentiation from hitherto recorded species (at Bombay) being the presence of transverse grooves on the abdominal segments. It was then identified as *Panulirus dasypus* (H. Milne-Edwards).

The record of an additional species necessitated a review of the taxonomy of the lobsters of Bombay. While doing so, it was found that there is considerable confusion in their identification. For example, the *Panulirus fasciatus* of Fabricius and Milne-Edwards is actually *Panulirus polyphagus* (Herbst), while the *Panulirus fasciatus* of De Haan is *Panulirus versicolor* (Latreille). Rai (1933) and Chopra (1939), both of whom have previously recorded these species from Bombay, have given them different names. Thus Rai has recorded them along the Bombay-Sind coast as *Panulirus ornatus* var. *decoratus* Heller cf. *P. versicolor* (Latr.), and *Panulirus fasciatus* (Fabr.) respectively, stating that the former is the more common. Chopra states that the common species of the Bombay coast is *Panulirus ornatus*, while *Panulirus polyphagus* (=*Panulirus fasciatus*) occurs commonly along the eastern coast of India. Actually, *P. polyphagus* is the prevalent species off the Bombay coast, *P. versicolor* being the rarest, although both Rai and Chopra have mentioned otherwise.

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[1] Communicated by the Director of Fisheries, Maharashtra State, Bombay.

Similarly, there is confusion in the identification of *P. versicolor* and *P. ornatus*. Barnard (1950), following de Man (1916), gives as the distinguishing character of *P. versicolor* the presence of a small single-jointed flagellum on the exopodite of the second maxillipede, whereas in *P. ornatus* the exopodite is without a flagellum, being only tipped with a small tuft of setae. Holthuis (1947), on the other hand, states that 'the presence of one or more segments of the flagellum of the exopodite of the second maxillipede in *P. versicolor* and the total absence of a flagellum in *P. ornatus* is rather variable in the former species, where it sometimes is absent too'. As such, dependence on the key devised by Barnard would lead to incorrect identification as regards these two species.

Classification of different species has been based, among other characters, on the relative lengths of the antennular and antennal peduncles and the walking legs. The authors, however, have found these characters to vary in individuals of different sizes, and hence these characters cannot be relied upon. The salient features of the three species of lobsters occurring at Bombay are given below. As stated by Holthuis, however, the most obvious character for identification is the colour pattern, and particular attention has been paid here to prepare a detailed colour description.

KEY TO IDENTIFICATION OF LOBSTERS OF BOMBAY

1. Abdominal somites with transverse grooves (interrupted medianly) ... *P. dasypus* (H. Milne-Edwards)
   Abdominal segments without transverse grooves[1] ... 2
2. Exopodite of second maxillipede with many-jointed flagellum ... *P. polyphagus* (Herbst)
   Exopodite of second maxillipede with either a small single-jointed flagellum, or without a flagellum ... *P. versicolor* (Latreille)

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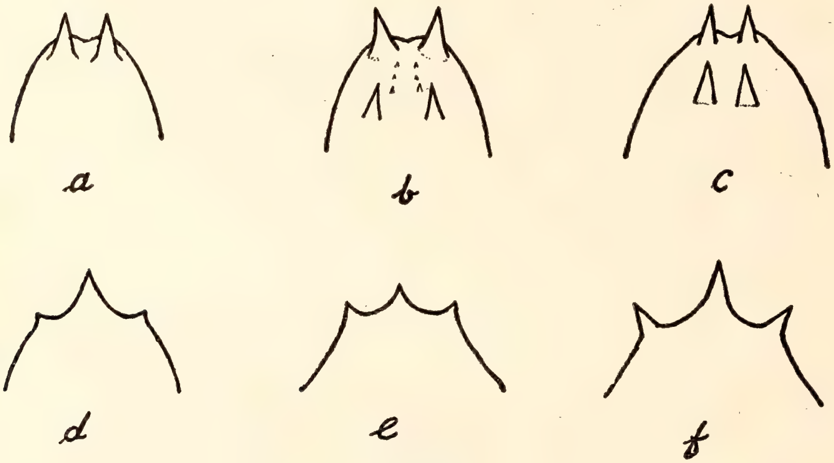
[1] Young specimens of *P. polyphagus* and *P. versicolor* may sometimes show traces of grooves.

DESCRIPTION OF SPECIES

Panulirus polyphagus (Herbst)

Cancer (*Astacus*) *polyphagus* Herbst, *Vers. Naturg. Krabben Krebse* 2 : 90 (1793).
Senex ornatus Ortmann, *Zool. Jahrb. Syst.* **6** : 34 (1891).
Palinurus fasciatus Fabricius, *Suppl. Ent. syst.* : 401 (1798).
Panulirus orientalis Doflein, *S. B. Bayer Akad. Wiss.* 30 : 130 (1900).
Panulirus fasciatus Milne-Edwards, *Hist. nat. Crust.* **2** : 295 (1837) ; Gavino, *Viaggio Circumnav. Caracciolo* : **6** (1888); Annandale, *J. Bombay nat. Hist. Soc.* **18** : 927 (1908); Rai, ibid. **36** : 893 (1933).
Panulirus polyphagus Nobili, *Boll. Mus. Zool. Anat. comp. Torino* 18 (452) : 14 (1903) ; Borradaile, *Fauna Geogr. Mald. Laccad.* 2 (3) : 754 (1904); Chopra, *J. Bombay nat. Hist. Soc.* **41** : 223 (1939) ; Holthuis, *Temminckia* 7 : 136 (1947).
Panulirus Powell, *J. Bombay nat. Hist. Soc.* **18** : 360 (1908).

The antennular plate (text-fig. *a*) bears only one pair of spines, situated far forward. The median spine on the fused coxicerites of the antennae (text-fig. *d*) is much stronger and projects far in front of the two minute lateral ones. All three spines have wide bases.



Text-Figure

Antennular plates of : (*a*) *Panulirus polyphagus*, (*b*) *P. dasypus*, and (*c*) *P. versicolor*. Fused coxicerites of the antennae of : (*d*) *P. polyphagus*, (*e*) *P. dasypus*, and (*f*) *P. versicolor*.

The dimensions of a medium-sized individual are:

total length ...	250 mm.
length of carapace ...	110 mm.
length of supra-orbital spine ...	16.5 mm.

The cephalothorax and abdomen have a muddy-brown colour. There is a row of six white spots on each of the lateral regions of the carapace—the anteriormost spot being larger than the rest. Small spines arise from these spots. From the postero-lateral corner of the carapace to the region of the mouth parts runs a white stripe, terminating in a broad white patch; another white stripe starts from the same place, running along the bases of the legs. The spines on the carapace have a brown base with yellowish tips. The antennular flagella are alternately banded crimson and white.

Each of the abdominal somites has a brown transverse band on the hind margin, with a narrow cream-coloured stripe running through it. This stripe in the first segment may be broken. The hinder third of the telson and uropods has a reddish tinge. The telson, uropods, and abdominal appendages are bordered with cream-coloured lines. The legs are brownish red, cream at the joints.

This lobster is locally known as 'shevand'.

DISTRIBUTION. Mauritius, India, Malay Archipelago, Indochina, Japan, and Polynesia. It has been previously recorded from Bombay by Nobili (1903), Annandale (1908), Powell (1908), Rai (1933), and Chopra (1939).

Panulirus dasypus (H. Milne-Edwards)

Palinurus dasypus H. Milne-Edwards, *Hist. nat. Crust.* **2** : 300 (1837).

Panulirus dasypus Henderson, *Trans. Linn. Soc. Lond., Zool.*, (ser. 2) **5** : 433 (1893); Thurston, *Bull. Madras Govt. Mus.* **3** : 120 (1895); de Man, *Siboga Exped. Rep.* 39a2:48 (1916); Gravely, *Bull. Madras Govt. Mus.* (ser. 2) **1**:138 (1927); Holthuis, *Temminckia* **7** : 134 (1947); Barnard, *Ann. S. Afr. Mus.* **38** : 549 (1950).

Senex dasypus Ortmann, *Zool. Jahrb. Syst.* **6** : 33 (1891).

There are four spines on the antennular plate (text-fig. *b*), the posterior two being about $\frac{2}{3}$ the length of the anterior two and being a little less distant from each other. A double row of spinules is present between them. The three spines on the fused coxicerites of the antennae (text-fig. *e*) are minute, sub-equal, and placed in a line. The exopodites of the second maxillipedes hardly reach the extremity of the merus. The first pair of legs are much stouter than in the other two species.

Two spines are present in the middle line of the gastric region, just in front of the cervical groove, and placed behind one another. The abdominal pleura end almost horizontally.

The dimensions of a medium-sized individual are:

total length	...	250 mm.
length of carapace	...	112 mm.
length of supra-orbital spine	...	21.5 mm.

The cephalothorax and abdomen are of a bluish grey colour, speckled throughout with minute whitish spots. There is a row of six to seven white spots (from which spines arise) on each of the lateral regions of the carapace, the anteriormost being larger than the rest. From the postero-lateral corner of the carapace to the region of the mouth parts runs a blue line, terminating in a broad white patch; another white line starts from the same place and runs parallel to the bases of the legs. The spines on the carapace are light brown with yellowish tips. The antennular flagella are alternately banded brown and white. There is a blue line between the eyes, on the antennular plate, and on the branchio-cardiac groove.

Two lateral white spots are present on each abdominal segment. The hinder third of the telson and uropods have a reddish tinge. The telson, uropods, and abdominal appendages are bordered with cream-coloured lines. The legs are yellowish brown, blotched with irregular cream spots.

DISTRIBUTION. From the western Indian Ocean to Japan and Malay Archipelago.

Panulirus versicolor (Latreille)

Palinurus versicolor Latreille, *Ann. Mus. Hist. nat. Paris* **3** : 394 (1804).
Palinurus taeniatus Lamarck, *Hist. nat. Anim. sans Vert.* **5** : 211 (1818).
Palinurus fasciatus De Haan, *Fauna Japonica, Crust.* : 159 (1841).
Palinurus (*Panulirus*) *ornatus* var. *decoratus* Heller, *Reise Novara Zool.* **2** : 99 (1865).
Panulirus demani Borradaile, *Willey's Zool. Results* **4** : 418 (1899).
Panulirus ornatus Rathbun, *Proc. U. S. Nat. Mus.* **38** : 560 (1910) ; Chopra, *J. Bombay nat. Hist. Soc.* **41** : 224 (1939) ; var. *decoratus* de Man, *Siboga Exped. Rep.* 39a**2** : 54 (1916) ; Rai, *J. Bombay nat. Hist. Soc.* **36** : 893 (1933) ; var. *laevis* de Man, *Siboga Exped. Rep.* 39a**2** : 55 (1916).
Panulirus versicolor de Man, *Siboga Exped. Rep.* 39a**2** : 55 (1916); Holthuis: *Temminckia* **7** : 142 (1947) ; Barnard, *Ann. S. Afr. Mus.* **38** : 553 (1950).
Senex ornatus var. *laevis* Lanchester, *Proc. Zool. Soc. Lond.* : 557 (1901).

The antennular plate (text-fig. *c*) bears two pairs of spines. The posterior pair are slightly smaller and more closely situated than the anterior pair; there are, very rarely, two denticles in front of and between them. The three spines on the fused coxicerites of the antennae (text-fig. *f*) are large and sub-equal, the median one being slightly in advance of the lateral ones.

The supra-orbital spines are much longer and stronger than in the preceding two species. The spines at the antero-lateral angles of the carapace have their tips directed slightly outward. The spines between these and the supra-orbital spines are also directed outward, not forward. The three sub-median pairs of spines in front of, and the three pairs behind, the cervical groove form a parallel series. The groove along the posterior margin of the carapace is not of uniform width, but widens in the median part.

The dimensions of a medium-sized individual are:

total length	... 256 mm.
length of carapace	... 108 mm.
length of supra-orbital spine	... 28 mm.

The cephalothorax and abdomen have a green ground colour. The carapace is marbled with confluent black spots and blotches, edged with white. These spots continue on to the supra-orbital spines. The antennules (including the flagella) have alternate black and yellowish-white longitudinal stripes. The antennal peduncles are pink, their spines having black bases with lemon-green tips. The flagella have green and white longitudinal stripes. The walking legs have white stripes on a black background.

Each of the abdominal somites has a black transverse band on the hind margin, with a narrow white stripe running through it. The borders of the telson, uropods, and abdominal appendages are fringed with white, while the abdominal appendages also have a white central stripe. The spinules on the telson and uropods have a green base with golden tips.

This lobster is locally known as 'manjri shevand'.

DISTRIBUTION. From the east coast of Africa to Japan and Polynesia. It has been previously recorded from Bombay by Rai (1933) and Chopra (1939).

ACKNOWLEDGEMENTS

The authors wish to express their grateful thanks to Dr. C. V. Kulkarni, Director of Fisheries, and Dr. H. G. Kewalramani, Research Officer, for critically going through their paper and for making available the necessary facilities for observations.

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Nobili, G. (1903) : Crostacei di Pondichéry, Mahé, Bombay, etc. *Boll. Mus. Zool. Anat. comp. Torino* **18** (352) : 1-24, pl. i.

Powell, A. (1908) : *Panulirus*, or 'the spiny lobster' of Bombay. *J. Bombay nat. Hist. Soc.* **18** : 360-389, pls. A, B, 11 text-figs.

Rai, H. S. (1933) : The shell-fisheries of the Bombay Presidency. Part II. ibid. **36** : 884-897, pls. i, ii, 2 blocks, 3 text-figs.

Thurston, E. (1895) : Rameswaram Island and Fauna of the Gulf of Manaar. *Bull. Madras Govt. Mus.* **1** (1).

Studies on the Freshwater Oligochaeta of South India[1]

I. Aeolosomatidae and Naididae

PART 1

BY

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(*With three text-figures*)

INTRODUCTION

The literature on the freshwater oligochaete fauna of the Indian sub-continent reveals that the group was worked out around Lahore of the North-Western Territory[2] and Calcutta of the Indo-Gangetic Plain area by Stephenson (1907-1925), Annandale (1905-1906), and Mehra (1920-1922), and around Travancore of the Southern Region by Aiyer (1924-1930). As a result of their work, they have recorded 25, 18, and 17 species of worms belonging to Aeolosomatidae and Naididae for the Southern Region, Indo-Gangetic Plain area, and North-Western Territory respectively. Ceylon, Western Region, Main Peninsular Region, Western Himalayan Region, North-East Frontier Region, and Burma are known to have 4, 5, 4, 5, 0, and 3 species respectively (Table I). After 1930 serious work on the group was not undertaken by anybody in the sub-continent.

This paper deals with taxonomic diagnoses of 35 species of worms belonging to 2 families and 10 genera, including a new subfamily and a new genus, 7 new species, 11 new records for the Southern Region, and 2 new records for the Indian sub-continent. The description of each of the species is made from 2 or 3 typical forms, which will be deposited as holotype and syntypes in the Indian Museum, Calcutta, India. The descriptions of new species include a diagnosis of the species.

Lastockinia gen. nov. is created to receive an aberrant species *Aeolosoma nieznestnovae* Lastockin (1935). Its diagnosis is given. Stephensonianinae nov. is created here for genus *Stephensoniana* Cernosvitov, which is occupying a solitary position under subfamily Naidinae. With the removal of this genus the Naidinae is more limited than it was according to Sperber.

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[1] Communicated by the Principal, Govt. Arts College, Cuddapah, in November 1959.

[2] This and the other regions mentioned are listed by Stephenson in the FAUNA volume on Oligochaeta (1923).

The other 28 species treated here are : 3 species of *Aeolosoma* belonging to the Aeolosomatidae ; and 3 species of *Chaetogaster*, 1 species each of *Nais*, *Haemonais*, *Stylaria*, *Branchiodrilus*, and *Stephensoniana*, 6 species of *Dero*, 3 species of *Aulophorus*, 2 species of *Allonais*, and 6 species of *Pristina*, all belonging to the Naididae. Their re-descriptions are based on 3 or 4 typical forms of each species (except in *Pristina jenkinae*), which will be deposited in the Indian Museum.

Keys to the subfamilies of Naididae, to all the genera of Aeolosomatidae, to the subfamilies of the Naididae, and to all the known and valid species of the 10 genera treated here are given.

Complete synonymies of the majority of the species of the Naididae are published by Sperber (1948). Wherever the synonymies established by her are accepted, a repetition has been avoided by citing her paper. Only synonymies established by the author are included. Important papers published subsequent to 1948 are referred to. Complete synonymies are given for the 3 species of the Aeolosomatidae.

The descriptions of new species and re-descriptions of known species include details regarding external characters, setal characters, digestive system, septa, coelomocytes, brain, blood vessels, nephridia, budding zones, sex organs, size of worms, etc. The measurements of the setae and the positions of the nodulus are tabulated for most of the species. Sketches of setae of all the species, and of the brain and nephridia of most of the species are included. In addition the habits of many species, and parasites and commensals of a few species are incorporated.

All the 35 species described here were collected from the following freshwater sources in south India during the periods and visits noted against them :

Localities	Period of collection	No. of visits	No. of species
Bugga Stream, Cuddapah	Sept. '52—April '56 Aug. '57—March '58	Numerous	32
Pullalamadugu Stream, Cuddapah	10 . 9 . 1955	One	1
Handri River, Kurnool	9 . 4 . 1958	One	1
Balaji Tank, Kakinada	April-Dec. 1956	Three	9
Kandakam Tank, Bellary	April-May 1954	Five	11
Brucepettah Tank, Bellary	April-May 1954	Four	3
Miller's Tank, Bangalore	April-May 1958	Two	2
Langford Town Tank, Bangalore	April-May 1958	Six	9
Ulsoor Tank, Bangalore	April-May 1958	Two	8
Sewage canal across Audagodi-Hosur Road, Bangalore	April-May 1958	One	1

The collections were made from Bugga Stream all round the year during the 4½ years, unlike in other localities. During this period it was found that certain species of worms which are abundant in particular months are scarce or nearly absent in subsequent months, their place having been taken by some other species of worms. Thus, there is a seasonal variation in the density of populations of all the species of worms round the year.

Asexual reproduction by budding is common in all species and occurs throughout the year. Sexual reproduction is rare, occurring only seasonally. Many species of worms develop sex organs from January to June. During the time that sex organs are developed all the species of worms suspend asexual reproduction except *Stylaria fossularis* and *Pristina longiseta longiseta*, which go through asexual reproduction along with the development of sex organs.

In every freshwater source some freshwater oligochaete or other was collected. From Bugga Stream alone, where collections were made intensively, 32 species of Aeolosomatidae and Naididae, 5 species of Tubificidae[1], and 1 species of Enchytraeidae[1], were collected. This number is the world record for a single water source. It is possible that many other water sources would provide as many species of freshwater oligochaetes if intensive collections were undertaken. In others only samples of mud and water were taken and casual examination for freshwater oligochaetes was made. Even such casual examination has yielded between 1 and 11 species from them. From this it is evident that freshwater oligochaetes are available in all fresh waters.

II. ACKNOWLEDGEMENTS

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[1] These will be dealt with in a subsequent paper.

III. Material and Methods

Collection: The worms inhabiting the aquatic plants, algae, decaying vegetable matter, etc. were collected either by shaking up decaying leaves, wood, cloth, etc. in water in dissection trays or by leaving the algae and aquatic plants in large quantities of water in beakers for a day or two, thus allowing them to settle on the walls of containers, and pipetting them out. The mud-dwellers were collected by washing samples of mud in trays and pipetting the coiled and moving worms from small quantities of water.

Observation: Observations were made mainly on living worms. Morphological studies were made chiefly on: the shape, number, position, and lengths of setae ; the shape of the gut and brain ; the position of the dorsal vessel, the number and position of contractile lateral vessels ; the shape, structure, and number of nephridia ; the number and position of the budding zones ; the position, shape, and structure of the sex organs. The modes of locomotion and habits of the worms were also noted. Fresh setal preparations were made by crushing the worms between cover glass and slide for studying the number, shape, and length of setae. Permanent setal preparations were made by crushing the worms between the cover glass and slide and sealing off with Canada balsam. Many sketches were drawn to measurements and others by the use of the camera lucida.

Measurements: All measurements were made using the eye-piece micrometer. The lengths of the setae and the position of the nodulus in the ratio D : P (the length of the shaft distal to the nodulus : the length of the shaft proximal to the nodulus) is given for all the Naididae. When a single measurement is given for the setae, it is the length of the longest seta in the bundle. Needle-setae and hair-setae are referred to as needles and hairs ; ventral setae are referred to as crotchets occasionally. When the teeth of needles are equally long, the tooth on the side of the concave curvature is referred to as the inner and the other as the outer. The teeth of the setae are referred to as teeth in needles and as prongs in ventral setae.

IV. Aeolosomatidae and Naididae of the Southern Region in India and their Geographical Distribution

Stephenson (1923) tabulates only the following six species for the Southern Region : (1) *Nais communis*, (2) *Nais* (*=Allonais*) *pectinata*, (3) *Naidium* (*=Pristina*) *breviseta*, (4) *Pristina longiseta* (*=Pr. longiseta longiseta*), (5) *Branchiodrilus semperi*, and (6) *Br. menoni*. Of these the last named is a synonym of *Br. semperi* (cf. Sperber, 1948). Hence, there were only five valid species of Naididae and no Aeolosomatidae known for the Southern Region till 1923. In Travancore, Aiyer (1925, 1926, and 1930) recorded 19 more species, Stephenson (1925b) added 2 species, and Sperber (1958) added one species to the region. They are (1) *Aeolosoma bengalense*, (2) *Ae. hemprichii*, (3) *Ae. travancorense*, (4) *Nais pectinata inaequalis* (=*Allonais inaequalis*), (5) *Naidium* (=*Pristina*) *menoni*, (6) *Pristina aequiseta*[1] (7) *Pr. proboscidea paraguayensis* (=*Pr. proboscidea*), (8) *Stephensonia* (=*Stephensoniana*) *trivandrana*, (9) *Slavina appendiculata*, (10) *Dero zeylanica*, (11) *D. limosa* (=*digitata*), (12) *D. austrina* (=*dorsalis*), (13) *D. pectinata*, (14) *D. palmata*, (15) *D. nivea*, (16) *Aulophorus furcatus*, (17) *A. michaelseni*, (18) *A. tonkinensis*, (19) *Nais* (=*Allonais*) *paraguayensis paraguayensis*, (20) *Aulophorus gravelyi*, (21) *Pristina synclites*, and (22) *Pr. foreli*. Thus, the number of species known for the Southern Region was 27 in 1958. With the 18 species mentioned in the next paragraph the number now stands at 45.

The thirty-five species treated here include 7 new species, and 11 new records for the Southern Region. They are *Nais menoni* sp. nov., *Dero indica* sp. nov., *D. plumosa* sp. nov., *Aulophorus hymanae* sp. nov., *A. indicus* sp. nov., *Allonais rayalaseemensis* sp. nov., and *Pristina sperberae* sp. nov. ; *Chaetogaster diastrophus* (Gruithuisen), *Ch. langi* Bretscher, *Ch. cristallinus* Vejdovsky, *Stylaria fossularis* Leidy, *Haemonais waldvogeli* Bretscher, *Dero cooperi* Stephenson, *D. sawayai* Marcus, *Allonais gwaliorensis* (Stephenson), *Pristina minuta* (Stephenson), *Pr. aequiseta* Bourne, and *Pr. jenkinae* (Stephenson). Of these *Dero sawayai* and *Pristina jenkinae* are new records for the Indian sub-continent. As a result 45 species are known for the Southern Region and 53 species for the Indian sub-continent.

TABLE I

DISTRIBUTION OF AEOLOSOMATIDAE AND NAIDIDAE IN THE NINE GEOGRAPHICAL REGIONS OF THE INDIAN SUB-CONTINENT

—	Ceylon	Southern Region	Western Region	Main Peninsular Region	Indo-Gangetic Plain area	North-western Territory	Western Himalayan Region	North-east Frontier Region	Burma
—	I	II	III	IV	V	VI	VII	VIII	IX
AEOLOSOMATIDAE									
1. *Aeolosoma bengalense** ..		+			+				
2. *Ae. hemprichii** ..		+				+			
3. *Ae. viridae* ..						+			
4. *Ae. travancorense** ..		+							
5. *Ae. ternarium*[2] ..	+								

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[1] This was an incorrect identification. The species was really *Pr. evelinae*.

[2] Doubtful validity.

* Species treated in this paper.

TABLE I—(*contd.*)

—	Ceylon	Southern Region	Western Region	Main Peninsular Region	Indo-Gangetic Plain area	North-western Territory	Western Himalayan Region	North-east Frontier Region	Burma
—	I	II	III	IV	V	VI	VII	VIII	IX
NAIDIDAE									
6. *Chaetogaster diastrophus** ..		+				+			+
7. *Ch. langi** ..		+	+		+				
8. *Ch. diaphanus* ..						+			
9. *Ch. cristallinus** ..		+			+				
10. *Ch. limnei limnei* ..							+		+
11. *Ch. limnei bengalense* ..			+		+	+			+
12. *Nais communis** ..		+	+		+	+	+		
13. *N. menoni* sp. nov.* ..		+							
14. *N. barbata* ..					+				
15. *N. elinguis* ..					+				
16. *N. raviensis* ..						+			
17. *Slavina appendiculata* ..		+			+	+	+		
18. *Stylaria fossularis** ..		+			+	+	+		
19. *Haemonais waldvogeli** ..		+			+	+			
20. *Branchiodrilus semperi** ..		+							
21. *Br. hortensis* ..					+	+			
22. *Dero dorsalis** ..		+							
23. *D. digitata** ..		+							
24. *D. indica* sp. nov.* ..		+							
25. *D. zeylanica** ..	+	+							
26. *D. cooperi** ..		+			+	+			
27. *D. nivea** ..		+							
28. *D. sawayai** ..		+							
29. *D. pectinata* ..		+							
30. *D. plumosa* sp. nov.* ..		+							
31. *D. palmata* ..		+							
32. *Aulophorus furcatus** ..		+	+			+			
33. *A. michaelseni** ..	+	+							
34. *A. hymanae* sp. nov.* ..		+							
35. *A. gravelyi* ..		+							
36. *A. indicus* sp. nov.* ..		+							
37. *A. tonkinensis** ..	+	+			+		+		
38. *Allonais inaequalis** ..		+			+				
39. *Al. paraguayensis paraguayensis* ..		+		+	+	+			
40. *Al. rayalaseemensis* sp. nov.* ..		+							
41. *Al. gwaliorensis** ..		+		+					
42. *Al. pectinata* ..		+		+	+				
43. *Stephensoniana trivandrana** ..		+							
44. *Pristina minuta** ..		+				+			
45. *Pr. menoni* ..		+							
46. *Pr. jenkinae** ..		+							
47. *Pr. synclites** ..		+							
48. *Pr. breviseta* ..		+							
49. *Pr. aequiseta** ..		+			+	+			
50. *Pr. evelinae** ..		+							
51. *Pr. longiseta longiseta** ..		+	+	+	+	+			
52. *Pr. proboscidea* ..		+			+				
53. *Pr. foreli* ..		+							
54. *Pr. sperberae* sp. nov* ..		+							
	4	45	5	4	19	17	5	0	3

* Species treated in this paper

TABLE II

GEOGRAPHICAL DISTRIBUTION OF AEOLOSOMATIDAE AND NAIDIDAE

	Australia	Asia	Africa	Europe	America	
					North	South
AEOLOSOMATIDAE						
1. *Aeolosoma bengalense* ..		+				+
2. *Ae. hemprichii* ..		+	+	+	+	+
3. *Ae. travancorense* ..		+				+
NAIDIDAE						
4. *Chaetogaster diastrophus* ..		+		+	+	+
5. *Ch. langi* ..		+	+	+	+	+
6. *Ch. cristallinus* ..		+	+	+	+	
7. *Nais communis* ..		+	+	+	+	+
8. *Stylaria fossularis* ..		+		+	+	
9. *Haemonais waldvogeli* ..		+		+	+	+
10. *Branchiodrilus semperi* ..		+				
11. *Dero dorsalis* ..		+		+		+
12. *D. digitata* ..		+	+	+	+	+
13. *D. zeylanica* ..		+				
14. *D. cooperi* ..		+	+			+
15. *D. nivea* ..		+		+		
16. *D. sawayai* ..						+
17. *Aulophorus furcatus* ..	+	+	+	+	+	+
18. *A. michaelseni* ..		+				
19. *A. tonkinensis* ..		+	+			+
20. *Allonais inaequalis* ..		+	+			+
21. *Al. gwaliorensis* ..		+	? +			
22. *Stephensoniana trivandrana* ..		+				
23. *Pristina minuta* ..		+			+	+
24. *Pr. synclites* ..		+				
25. *Pr. jenkinae* ..		+	+			+
26. *Pr. aequiseta* ..		+	+	+	+	+
27. *Pr. evelinae* ..		+		+		+
28. *Pr. longiseta longiseta* ..	+	+	+	+		+
	2	27	13	14	11	19

V. SYSTEMATICS

Family AEOLOSOMATIDAE

Aeolosomatidae has only three valid genera, viz. *Hystricosoma* Michaelsen, 1926 ; *Aeolosoma* Ehrenberg, 1831 ; and *Potamodrilus* Lastockin, 1935. The very aberrant species *Aeolosoma nieznestnovae* Lastockin, 1935, without setae and with paired lateral tubercles on the body-wall and two post-anal appendages, does not fit into the genus *Aeolosoma* characterised by the presence of setae and by the absence of paired tubercles on the body-wall and post-anal appendages. I agree with the view of Marcus (1944) that a fourth genus is necessary to receive this aberrant species. As its presence in *Aeolosoma* is incongruous and as it does not fit into either *Hystricosoma* or *Potamodrilus*, the two other genera in the family, a new genus *Lastockinia* after the late Dr. D. A. Lastockin is created to receive it.

Genus **Lastockinia** gen. nov.

Generic type : *Lastockinia nieznestnovae* (Lastockin)

Prostomium not separated by a well-defined groove from the rest of the body, broader than following segments. External segmentation indistinct. Setae absent. Paired lateral tubercles and two post-anal appendages present. Skin glands usually present. Paratomy occurs.

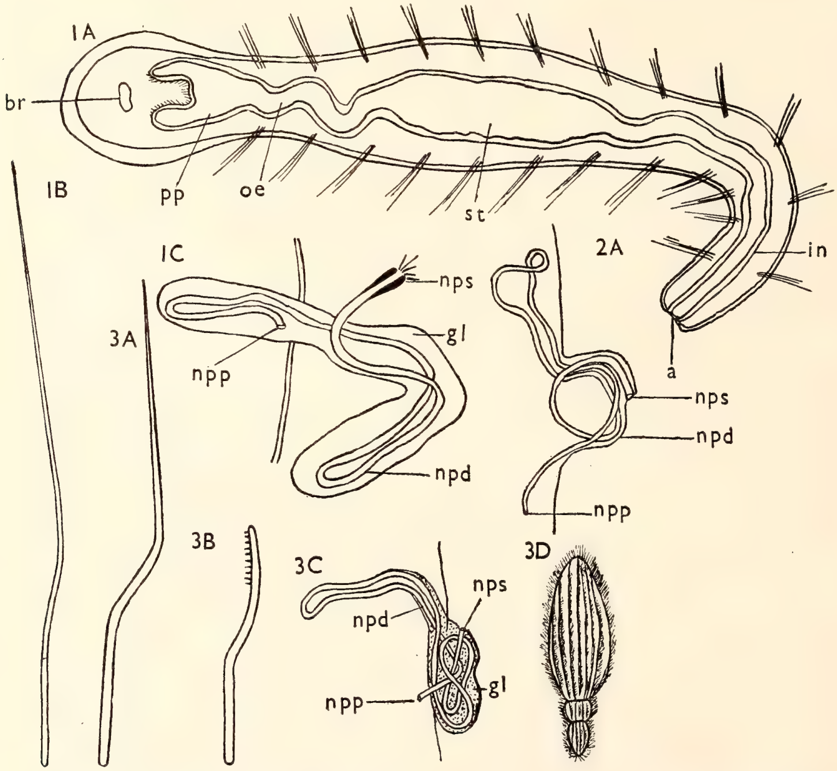

Fig. 1. *Aeolosoma bengalense* Stephenson: A. Entire worm (ventral view); B. Hair seta × 705; C. Nephridium. Fig. 2. *Aeolosoma hemprichii* Ehrenberg: A. Nephridium. Fig. 3. *Aeolosoma travancorense* Aiyer: A. Hair seta × *c*. 1000. B. Needle seta × *c*. 1000. C. Nephridium. D. Holotrichous Ciliate parasite, *Radiophryoides*.

a : anus; br: brain; gl: gland; in: intestine; npd: nephridial duct; npp: nephridiopore; nps: nephrostome; oe: oesophagus; pp: pharynx; st: stomach.

Key to all the Genera of AEOLOSOMATIDAE

A-1 Setae present ; paired tubercles absent on body-wall
  B-1 Prostomium separated from the body by a well-defined groove **Hystricosoma*
  B-2 Prostomium not separated from body by well-defined groove
    C-1 Body provided with glandular post-anal appendage ; worms attached **Potamodrilus*
    C-2 Body without post-anal appendage ; worms not attached *Aeolosoma*
A-2 Setae absent ; paired tubercles present on body-wall .. **Lastockinia* gen. nov.

1. Genus **Aeolosoma** Ehrenberg, 1831

Generic characters : Eyes absent. Prostomium not separated from the body by well-defined groove, semi-circular, flat with or without lateral sensory ciliary pits. Skin glands coloured or colourless. Dorsal and ventral setae from II on, composed of hairs or hairs and needles. Pharynx funnel-shaped, oesophagus thin, stomach conspicuous, gut entirely ciliated ; intestinal anti-peristalsis and ascending ciliary vibration occur. Septa absent. Blood colourless ; dorsal vessel mid-dorsal and contractile ; ventral vessel mid-ventral and non-contractile ; lateral contractile vessels absent. Nephridia paired, start in II or III. Budding zones 1-4 or more ; produce prostomium and some anterior segments to posterior zooid, and some hind segments to anterior zooid, before fission.

Key to the known and valid Species of *AEOLOSOMA*

A-1 Secretions of skin glands coloured
  B-1 Secretions of skin glands red, orange or dark garnet
    C-1 Needle setae present
      D-1 Needle setae smooth, present in ventral bundles only ; skin glands red, present dorsally .. **evelinae*
      D-2 Needle setae toothed in dorsal and ventral bundles ; skin glands present dorsally and ventrally, light red .. **corderoi*
    C-2 Needle setae absent
      E-1 All the setae of a bundle are equal in length **quarternarium*
      E-2 Setae of bundles are of different lengths
        F-1 Skin glands reddish, occurring only dorsally ; stomach in V-XI .. **gertae*

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* Genera not known from the Indian sub-continent

- F-2 Skin glands reddish, occurring both dorsally and ventrally; stomach in VI-VII
  - G-1 Ciliated pits present on prostomium; skin glands red .. *hemprichii*
  - G-2 Ciliated pits absent on prostomium; skin glands red and green .. **kashyapi*

- B-2 Secretions of skin glands yellow, green, lemon, olive or blue-green
  - H-1 Needle setae present
    - I-1 Needle setae smooth
      - J-1 Needle setae present from III .. **leidyi*
      - J-2 Needle setae present from V .. **tenebrarum*
    - I-2 Needle setae serrated
      - K-1 Skin glands yellowish orange; teeth on convex border of needle setae distally .. **japonica*
      - K-2 Skin glands bright yellow; teeth on concave border of needle distally .. **sawayai*
  - H-2 Needle setae absent
    - L-1 Zone of fission between VII and X
      - M-1 Skin glands yellow .. **flavum*
      - M-2 Skin glands yellowish green
        - N-1 Nephridia begin in II .. *viridae*
        - N-2 Nephridia begin in III
          - O-1 Nephridial funnel narrow; n=8-9 .. **variegatum*
          - O-2 Nephridial funnel wide; n=10 .. **pointneri*
    - L-2 Zone of fission between XI and XV
      - P-1 Stomach upto XI .. **headleyi*
      - P-2 Stomach upto VIII
        - Q-1 Ciliated fields present on dorsal surface of prostomium; body-diameter 0.2-0.3 mm. .. *bengalense*
        - Q-2 Ciliated fields absent; body-diameter 0.06-0.1 mm. .. **aureum*

A-2 Secretions of skin glands colourless
- R-1 Needle setae present
  - S-1 Needle setae serrated (under oil immersion) .. *travancorense*
  - S-2 Needle setae smooth .. **beddardi*
- R-2 Needle setae absent .. **niveum*

1. **Aeolosoma bengalense** Stephenson, 1911

Fig. 1, A, B.

Aeolosoma bengalense Stephenson, 1911, p. 204.

Aeolosoma bengalense Stephenson: Stephenson, 1923, p. 41; 1930, p. 136. Aiyer 1926, p. 131, fig. 1-3. Michaelsen & Boldt, 1932, p. 590. Marcus, 1944, pp. 16-17, fig. 5 A, B. Du-Bois Raymond Marcus, 1944, p. 5, fig. 11-12. Yamaguchi, 1953, pp. 280-281, fig. 1.

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* Species not known from the Indian sub-continent

Aeolosoma sp. 1. Stephenson, 1931b, p. 298.

Material examined: Numerous worms collected from the Bugga Stream, Cuddapah in July 1955, and from Ulsoor Tank, Bangalore, in May 1958.

Worms (Fig. 1 A) whitish and of medium size. Prostomium with sensory hairs, wider than anterior segments, about equal to the widest body-diameter, with ventral ciliation and two small dorso-lateral ciliated sensory pits. Body-wall colourless and transparent with skin glands of larger, variously shaped, dirty yellow or greenish yellow, and of smaller ovoid blue colour.

Dorsal and ventral bundles composed of hairs and needles ; hairs (Fig. 1 B) bayonet-shaped, non-serrate, 280-350 μ long, 1-4 per bundle dorsally, and 200-220 μ long, 4-7 per bundle ventrally ; needles non-serrate, bayonet-shaped, 140-180 μ long, 3-4 per bundle dorsally ; 100-120 μ long, 4-6 per bundle ventrally.

Mouth ventral, V-shaped. Pharynx in II, funnel-like. Oesophagus in III, thin and wavy. Stomach in IV-$\frac{1}{2}$VIII, fusiform and bright yellow. Intestine thin and wavy.

Brain ovoid with constrictions medially in front and behind.

Dorsal vessel arises in IV, runs dorsally over oesophagus and pharynx, divides into two, descends on either side of the pharynx and unites with non-contractile ventral vessel in II. Blood flows from behind forwards in dorsal and from anterior to posterior in ventral vessels.

First nephridial pair in II, last in IX or X. Nephridium (Fig. 1 C) has a minute funnel with a ciliated nephrostome, followed by a long coiled ciliated duct passing through glandular mass and opening to exterior by nephridiopore ventro-laterally. Cilia in the nephrostome and nephridial duct beat down the lumen.

Worms with 1-4 budding zones common. Some hind segments to the anterior zooid, and prostomium and a few anterior segments to the posterior zooid are budded before fission. As the first budding zone is proliferating segments to both the zooids, second, third, and fourth budding zones are developed, second zone in front of the first, third behind the first, and fourth anterior to the second zone.

Sexual worms not encountered.

l (preserved)=1.0–1.2 mm. ; d (preserved)=0.2 mm. ; s=12-15 ; n=9-10.*

Distribution in Indian sub-continent: Calcutta (N. India) ; Travancore (S. India). Now recorded from Cuddapah and Bangalore (S. India).

Habits: No swimming. Glides on substratum like Turbellarians.

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* l = length ; d = diameter ; s = number of segments of each worm ; and n=number of segments behind which budding zone develops.

2. **Aeolosoma hemprichii** Ehrenberg, 1831

Fig. 2 A

Aeolosoma hemprichii Ehrenberg. Gervais, 1838, p. 14. Beddard, 1895, p. 183. Smith, 1900, p. 443. Michaelsen, 1900, p. 14; 1905, p. 305. Bretscher, 1906, p. 6. Pointner, 1911, p. 627. Piguet, 1913, pp. 112-113. Lastockin, 1918, p. 57; 1924, p. 4; 1927, p. 65. Svetlov, 1926, p. 250. Oye, 1927, p. 359. Ude, 1929, pp. 18-19. Cernosvitov, 1930, p. 9. Kondo, 1936, p. 382. Kenk, 1941, p. 6. Marcus, 1944, pp. 21-22, fig. 7 A, B. Chen, 1944, p. 1. Causey, 1953a, p. 55. Yamaguchi, 1957, pp. 161-163, fig. 1.

Aeolosoma venustum Leidy, 1850, p. 46, pl. II, fig. 8-12.
Aeolosoma pictum Schmarda, 1861, p. 10, pl. XVII, fig. 155.
Aeolosoma stokesii Cragin, 1887, p. 31.
Aeolosoma kashyapi Stephenson. Aiyer, 1926, p. 138.
Aeolosoma hemprichii var. *kashyapi* Stephenson. Chen, 1940, pp. 23-24, fig. 1a.

Material examined: Numerous worms collected from the Bugga Stream, Cuddapah in October and December 1955; from the Balaji Tank, Kakinada in December 1956; from the Kandakam Tank, Bellary in April 1954 and 1956.

Worms minute, transparent, colourless and invisible to naked eye. Integument has numerous spherical and ovoid deep red cutaneous glands, scattered irregularly dorsally and ventrally, with concentration in prostomium and anal segment. Prostomium wider than body diameter, with marginal sensory hairs, ventral ciliation and lateral sensory ciliated pits. Its margin is highly mobile, constantly curling up and down as the worm glides along the substratum.

Each seta-bundle has 3-5 bayonet-shaped hairs only; when 3, central hair longer than others, when 4, alternate ones longer, when 5, 3 longer and 2 shorter. Longer hairs 90-120 μ long.

Mouth semi-circular with a thick ciliated rim. Pharynx in II, short and funnel-shaped. Oesophagus in III, thin. Stomach in IV-VI, barrel-shaped and brown. Intestine thin and sinuous from VII. Food material rotates on its axis during its course through the gut. Coelomocytes translucent, ovoid or spindle-shaped.

Brain dumb-bell-shaped.

Dorsal vessel mid-dorsally attached to gut, divides anteriorly into two, branches unite with non-contractile ventral vessel below the pharynx.

Nephridia two per segment from II or III to IX. Nephridium (Fig. 2 A) is a long coiled ciliated duct with a ciliated nephrostome anteriorly opening into the coelom, the duct traverses glandular mass and ends by nephridiopore.

Worms with 2-4 budding zones common.

l (living)=1.8 mm.; d (living)=0.06 mm.; s=12-14; n=7-8.

Distribution in Indian sub-continent: Travancore (S. India); Lahore (Pakistan). Now recorded from Cuddapah, Bellary, Kakinada (S. India).

Remarks : Stephenson (1909a) identified the Lahore aeolosomatids with deep orange skin glands as *Ae. hemprichii* and separated them as *Ae. kashyapi* (1923) purely on the basis of their small size and the presence of equally long setae in the bundles. Ciliated pits are stated to be absent (Stephenson, 1909a). This important character was overlooked by him in his diagnosis of *Ae. kashyapi* and he created the new species on the differences in size and setae from *Ae. hemprichii.* Aiyer (1926) also failed to observe this important character. Examining both *Ae. kashyapi* and *Ae. hemprichii* in Brazil, Marcus (1944) found ciliated pits absent in the former and present in the latter. He distinguished the two species mainly on the presence and absence of the ciliated pits. He also found a few greenish skin glands among the red ones in *Ae. kashyapi.* Brazilian worms are 2 mm. long, Japanese worms are 1.5 mm. long (Yamaguchi, 1957) and Chinese worms are 3 mm. long (Chen, 1940). Bayonet-shaped hairs and needles observed in the present worms were not pointed out by the previous writers.

Habits : Swimming absent ; gliding occurs. Backward progression by series of jerks.

3. **Aeolosoma travancorense** Aiyer, 1926

Fig. 3 A–D

Aeolosoma travancorense Aiyer, 1926, p. 136; 1930, pp. 16-19, fig. 1. Stephenson, 1930, pp. 723, 725. Marcus, 1944, pp. 24-25, fig. 11, 12, 15, 75.

Material examined : Many worms collected from the Bugga Stream, Cuddapah in November 1953, June 1954 and December 1955.

Worms minute, whitish and live in tubes larger than themselves, made of sand, mud and mucus. Integument with colourless ovoid skin glands. Prostomium wider than body diameter and highly flexible. Prostomium and anal segment bear sensory hairs.

Dorsal and ventral bundles composed of hairs and needles. In II all are hairs, from III needles replace hairs, middle segments have 2-3 needles and 2-3 hairs, hind segments have all needles. Hairs (Fig. 3 A) are bayonet-shaped, 63-80 μ long. Needles (Fig. 3 B) are thicker and half as long as hairs, bayonet-shaped, 35-38.5 μ long, with one row of 10-12 teeth in the concave border distally.

Mouth ventral, four-cornered and ciliated. Pharynx in II, funnel-shaped. Oesophagus in III, thin and wavy. Stomach in IV-VII, wide, orange coloured. Intestine thin and ciliated, opening posteriorly in anus. Coelomocytes absent.

Brain dumb-bell-shaped.

Dorsal vessel mid-dorsal and contractile ; ventral vessel mid-ventral and non-contractile. No contractile vascular loops.

First pair of nephridia in III ; nephridium (Fig. 3 C) is a long coiled, ciliated duct with a ciliated nephrostome opening in the coelom, a minute nephridiopore opening to exterior ventrolaterally, and proximal half of the duct compactly coiled and enclosed in gland tissue.

Budding zones 1-3 common ; provide some hind segments to the anterior zooid and prostomium and head segments to the posterior zooid before they separate.

l (living)=1.0 mm. ; d (living)=0.07 mm. ; s=12-13 ; n=7-8.

Distribution in Indian sub-continent : Travancore (S. India). Now recorded from Cuddapah (S. India).

Parasites : In the gut of several worms astomatous ciliates belonging to genus *Radiophryoides* (Fig. 3 D) are harboured as parasites. They are light green in colour in life, with flatly ovoid body, 160-180 μ long, 70-78 μ wide and 35-40 μ thick, with longitudinal rows of cilia. They move slowly rotating on their axes. Several ciliates have 1-2 buds attached posteriorly.

Remarks : Aiyer (1926) states the presence of two rows of very minute teeth in the concave border of the needles. I could see only one row of them under oil immersion. The ciliate parasites have been found by Aiyer (1930) in his worms.

Habits : No swimming. Moves by gliding.

(To be continued)

The Birds of Nepal

PART 5

BY

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[*Continued from Vol.* **58** (2) : 474]

Family MUSCICAPIDAE

Subfamily TURDINAE

*413. **Brachypteryx stellatus stellatus** Gould. Gould's Shortwing.

Gould's (1868, p. 218) description was based on one of the two specimens obtained by Lieut. Eccles from Nepal, the other specimen was presented to the British Museum. However, both these specimens were stated as coming from Sikkim by Sharpe (1883, p. 31) for reasons best known to him. The only specimen that undoubtedly came from Nepal was taken by Stevens (1925a, p. 356) in the Mai Valley, eastern Nepal, at *c*. 2135 m. on April 8.

*414. **Brachypteryx leucophrys nipalensis** Horsfield & Moore. Nepal Shortwing.

The Nepal Shortwing is known from Nepal only from four specimens, two of which (types) were presented by Hodgson to the Museum of the East India Company in 1853 when he was living in Darjeeling. It may therefore, be presumed that they came from eastern Nepal. The other two specimens were collected by Stevens (1925a, p. 357) from the Mai Valley, eastern Nepal, at *c*. 2135 m. in early April.

415. **Brachypteryx montana cruralis** (Blyth). Whitebrowed Shortwing.

BHABAR : Amlekhganj : 2 ♀♀ (March 8). MARKHU VALLEY : Deorali : 2 ♂♂, 1 ♀ (April 29, May 2). CHITLANG VALLEY : Chitlang : 1 ♂ (April 22). NEPAL VALLEY : Thankot : 1 ♀ (April 12).

The Whitebrowed Shortwing is not easily seen due to its habit of skulking in heavy undergrowth. It occurs as a solitary bird.

Scully (1879) and Ripley (1950b) failed to find it in Nepal, but Stevens (1925a, p. 357) took specimens in the Mai Valley, eastern

Nepal, at *c.* 2895 m. on April 8, and Rand & Fleming (1957, p. 148) reported it from central Nepal in the Nepal Valley and the dun.

All my male specimens are in female plumage. They all have the supercilium as in slaty blue specimens. The supercilium is, however, absent in my female specimens, as in Stevens's (loc. cit.) and Rand & Fleming's (loc. cit.) birds, although it is said to be present in females and is silky white (Baker, 1924, p. 18) or golden brown (Roonwal & Nath, 1949, p. 325) in colour. Stevens had already pointed out that the 'males in many cases breed . . . in the feminine phase of coloration. The white supercilium is present in males only . . .'; then he cited examples of two specimens, male and female 'both in similar plumage, female without supercilium', and stated further: 'All breeding males in female garb have supercilium as in slaty blue specimens.' With this I entirely agree. The descriptions of females given by Baker (loc. cit.), and Roonwal & Nath (loc. cit.) would, therefore, appear to be those of males in feminine plumage.

Measurements :

	Wing	Tail	Bill
3 ♂♂ :	68 (2), 69	42+, 45, 47.5	—, 16, 16.5
4 ♀♀ :	64, 66 (3)	43 (2), 44 (2)	15, 15.5, 16 (2)

*416. **Erithacus calliope calliope** (Pallas). Common Rubythroat.

The Common Rubythroat was not come across by us or by Scully (1879). Proud (1949, p. 702) once observed a single example in the Nepal Valley on April 1. Ripley (1950b, p. 386) found it in the Arun Valley, eastern Nepal, at *c.* 365 m. in February. Rand & Fleming (1957, p. 148) reported it in winter from *c.* 915 m. in west-central Nepal, and from *c.* 760 m. in eastern Nepal.

*417. **Erithacus svecicus svecicus** (Linnaeus). Redspotted Bluethroat.

We were unable to find the Bluethroat in Nepal; neither was Ripley (1950b). It was reported from the Nepal Valley in small numbers in winter by Scully (1879, p. 305) and Proud (1955, p. 60), but the latter author found it very common on passage. Rand & Fleming (1957, p. 149) found it throughout the Nepal tarai in winter.

418. **Erithacus pectoralis pectoralis** (Gould). Himalayan Rubythroat.

DUN : Bhimphedi : 1 ♀ (May 10). CHITLANG VALLEY : Chitlang : 1 subad. ♂ (March 14). NEPAL VALLEY : Thankot : 1 ♂, 1 ♀ (March 29, April 9).

The Himalayan Rubythroat is sporadically seen in central Nepal. We found it to be rather shy, keeping usually in or close to dense bushes.

It was reported in winter or spring from the Nepal Valley by

Scully (1879, p. 304), Proud (1955, p. 60) and Rand & Fleming (1957, p. 148). The last-named authors found it also in western Nepal at *c.* 4570 m. in winter. Lowndes (1955, p. 32) recorded it from Manangbhot, central Nepal, at *c.* 3960-4570 m. in July-August, obviously breeding.

The breeding altitude for this bird has been given as *c.* 2745-4570 m. (Baker, 1924, p. 93; Ripley, 1961, p. 496). Unless my May 10 specimen from *c.* 1280 m. (Bhimphedi) was a late comer from the winter grounds the species perhaps occasionally breeds at elevations lower than *c.* 2745 m. Unfortunately, no data on the specimen's breeding or the condition of the gonad were kept.

The subadult male specimen is olive-brown on the upper side.

Measurements :

	Wing	Tail	Bill
2 ♂♂ :	72[a], 74	55[a], 64	18[a], 18.5
2 ♀♀ :	68, 70	56, 61	17, 18

[a] Subadult specimen

According to Ripley (1961, p. 497) the breeding form in Nepal is the eastern subspecies, *E. p. confusus* (Hartert). However, Lowndes's specimens from central Nepal were identified by Kinnear as *pectoralis*. The breeding range of *confusus* probably starts from eastern Nepal (see next form, below).

*419. **Erithacus pectoralis confusus** (Hartert). Eastern Rubythroat.

The only authentic record of the Eastern Rubythroat from Nepal has been made by Biswas (1960a) who found it breeding in Khumbu, eastern Nepal, at *c.* 4570-4875 m. in April-May.

420. **Erithacus brunneus brunneus** (Hodgson). Indian Blue Chat.

DUN : Hitaura, Bhimphedi : 4 ♂♂, 3 subad. ♂♂, 6 ♀♀ (May 3-11). MARKHU VALLEY : Deorali : 2 ♂♂, 1 subad. ♂ (April 28-30). CHITLANG VALLEY : Chitlang : 5 ♂♂, 1♀ (April 22-27).

The Indian Blue Chat is common in central Nepal in dense forests, usually on the ground, but occasionally perching on trees also. Scully (1879) did not include it in his Nepal list. Stevens (1925a, p. 356) found it breeding in the Mai Valley, eastern Nepal, in April-May. It was reported from the Nepal Valley in March-April by Ripley (1950b, p. 386), and Rand & Fleming (1957, p. 149). Proud (1955, p. 60) reported it breeding there at *c.* 2560 m. in summer. Smythies (1950, p. 515) also made a doubtful record from the Nepal Valley (Phulchauki Danda) at *c.* 2590 m. in June. Polunin (1955, p. 890) found a single example at *c.* 2745 m. in the Langtang Valley, central Nepal, in summer.

The subadult birds have brown primaries, and in addition, two of them have the wing coverts with rufescent tips, and one has olive-brown feathers on the posterior crown and nape.

Measurements :

	15 ♂♂	7 ♀♀
Wing :	72.5[a], 73[a], 73, 74, 75[a], 76[a], 76, 76.5, 77 (2), 78 (2), 78.5, 79, 80	71, 71.5, 72 (2),—, 73, 74
Tail :	46[a], 47[a], 47, 48 (3), 49[a], 50[a], 50 (2), 51 (2), 52 (2), 53	44, 45,—,46 (2), 46.5, 50
Bill :	15.5[a], 16[a](3), 16 (5), 16.5 (2), 17 (2),—(2)	15.5, 16 (2), 16.5 (2), 17,—

[a] Subadult specimens.

It is said to breed from *c.* 1525 m. upwards (Baker, 1924, p. 15; Ripley, 1961, p. 497). However, we obtained specimens between *c.* 455 and 1220 m. in May, but no data on the breeding of these specimens is available.

421. **Erithacus cyanurus rufilatus** (Hodgson). Redflanked Bush Robin.

CHITLANG VALLEY: Chitlang, Chandragiri above Chitlang: 1 ♂, 1 (♂), 1 juv. ♂, 2 ♀♀ (March 15-18, April 22). NEPAL VALLEY : Thankot : 9 ♀♀ (March 21—April 2).

The Redflanked Bush Robin is not uncommon during March and April on the Chandragiri, sometimes even on trees overhanging the main Kathmandu trail. It usually occurs singly or in pairs and is of rather restless disposition.

Stevens (1925a, p. 354) recorded it from the Singalila Range, eastern Nepal, at *c.* 3100 m. in March-April. Proud (1949, p. 703) reported it common in the Nepal Valley at *c.* 1525 m. upwards in winter. Ripley (1950b, p. 386) found it in winter in western and eastern Nepal. Proud (1952a, p. 363) noted it as common in pairs up to *c.* 3350 m. in the Gandak-Kosi watershed, central Nepal, in spring. Polunin (1955, p. 891) found it in the Langtang Valley, central Nepal, at *c.* 3960 m. in summer. Lowndes (1955, p. 32) reported it very common in Manangbhot, central Nepal, at *c.* 3050-3960 m. in summer. Rand & Fleming (1957, pp. 149-150) found it in western, west-central and central Nepal, at *c.* 1370-2285 m. in winter and spring. Biswas (1960a) reported it preparing to breed in Khumbu, eastern Nepal, at *c.* 3810-4420 m. in March-May.

My juvenile male specimen appears to be a first year bird. It is in feminine garb, but the rump is blue and the upper breast slaty.

Measurements :

	1 ♂	1 (♂)	11 ♀♀
Wing :	84	81	77, 77.5, 78 (4), 79 (5)
Tail :	68	—	59 (2), 60 (3), 61 (2), 62 (2), 63, 65
Bill :	15.5	15	14, 14.5 (4), 15 (2), 15.5, 16,— (2)

An examination of fresh material from the Himalayas (Kashmir to Sikkim, including topotypes of *pallidior* Baker and *rufilatus* Hodgson) made me diffident to accept Baker's western Himalayan race *pallidior*. The alleged differences in coloration are apparent only when old western Himalayan birds are compared with comparatively recent collections from Nepal or Sikkim. The differences in size as given by Rand & Fleming (op. cit., p. 150) are not borne out in large series. Vaurie (1955b, p. 13) also came to the same conclusion as mine regarding the taxonomic status of *pallidior*. But Ripley (1961, p. 499) has recently upheld *pallidior*.

422. **Erithacus chrysaeus chrysaeus** (Hodgson). Golden Bush Robin.

NEPAL VALLEY: Thankot: 2 ♂♂, 1 ♀ (March 21-30).

The Golden Bush Robin is scarce in central Nepal. We observed it only on a few occasions up to mid-April on Chandragiri (above Thankot), always on the ground in dense bush or undergrowth.

It was not reported by Scully (1879), or by Ripley (1950b). Stevens (1925a, p. 353) found it in the Mai Valley, eastern Nepal, at *c.* 2135-2440 m. in early April. Smythies (1948, p. 441) reported it common above tree-line in the Gandak-Kosi watershed, central Nepal, in autumn. Proud (1949, p. 703) found it only on the Sheopuri Range in the Nepal Valley at *c.* 1830 m. up from November to February. Smythies (1950, p. 515) noted it in the Nepal Valley on Sheopuri and Phulchauki ranges in October. Polunin (1955, p. 891) observed it occasionally at *c.* 3505 and 4420 m. in the Langtang Valley, central Nepal, in summer. Rand & Fleming (1957, p. 149) found it in west-central and central Nepal (Nepal Valley) at *c.* 1405 and 1675 m. in winter. Biswas (1960a) recorded it preparing to breed at *c.* 4625 m. in Khumbu, eastern Nepal, in late April and early May.

A male specimen (March 23) has the central rectrices in moult.

Measurements :

	Wing	Tail	Bill
2 ♂♂ :	65, 66	53, —	15, 15.5
1 ♀ :	65.5	54	15

*423. **Erithacus indicus indicus** (Vieillot). Whitebrowed Bush Robin.

Neither Scully (1879) nor we found this bush robin in Nepal Proud (1949, p. 703) reported it as a scarce bird of the Nepal Valley on Nagar Jong in December-January. It was also recorded from eastern Nepal by Stevens (1925a, p. 354) in the Mai Valley, at *c.* 2440-2745 m. in March; by Ripley (1950b, p. 386) in the Arun Valley at *c.* 2745 m. in winter; by Rand & Fleming (1957, p. 150) at *c*. 3050 m. also in winter; and by Biswas (1960a) in Khumbu at *c*. 4265 m. in April-May.

*424. **Erithacus hyperythrus** (Blyth). Rufousbellied Bush Robin.

It appears that Hodgson's collection (Gray, 1863, p. 34), probably from eastern Nepal, and Stevens's (1925a, p. 354) single example from the Singalila Range, eastern Nepal, at *c*. 3595 m. taken on March 2, form the only records of the occurrence of the Rufousbellied Bush Robin in Nepal.

425. **Copsychus saularis saularis** (Linnaeus). Indian Magpie-Robin.

TARAI : Simra : 2 ♂♂ (March 4, 5). DUN : Hitaura, Kusumtar, Bhimphed : 2 ♂♂, 1 nestling ♂, 2 ♀♀, 1 nestling ♀ (March 14, May 14, 26, June 2). NEPAL VALLEY: Kathmandu, Thankot : 8 ♂♂, 2 (♂♂), 5 ♀♀ (March 21—April 14).

The Magpie-Robin is one of the commonest birds about human habitation in central Nepal, especially in the Nepal Valley. In the dun it did not appear to be as common.

Rand & Fleming (1957, p. 150) reported it also from western, west-central and eastern Nepal, up to *c*. 1405 m. in winter. Biswas (1960a) found it from the Nepal Valley east to the Singalila Range up to *c*. 1525 m. between January and July.

In the third week of March it was singing merrily and was starting its love-play. March and April birds had enlarged gonads.

Measurements :

	7 ♂♂	2 ♀♀
Wing :	101 (2), 101[a], 102[a], 103 (2), 106	93, 95
Tail :	92, 92[a] (2), 94 (3), 95	79, 82
Bill :	22, 22[a], 22.5, 23, —[a], —(2)	21.5, 22

[a] Unsexed but (♂♂)

426. **Copsychus malabaricus indicus** (Baker). Indian Shama.

BHABAR : Amlekhganj : 1 ♀ (March 6). DUN : Hitaura : 1 ♂ (May 27).

The Shama does not appear to be at all common in central Nepal. It was observed by us only a few times in the forests of the bhabar and the dun. However, Ripley (1950b, p. 388) found it to be common in the tarai forests of central Nepal, while Rand & Fleming (1957, p. 151) recorded it from the western, west-central and eastern tarai where they noted it as common. Scully (1879) did not include it in his Nepal list.

Measurements :

	Wing	Tail	Bill
1 ♂ :	96	147	21
1 ♀ :	90	118	19.5

*427. **Phoenicurus erythronotus** (Eversmann). Eversmann's Redstart.

The sole record of the occurrence of Eversmann's Redstart in Nepal is based on a single specimen taken at Jomosom (*c.* 2800 m.), Kali Gandak Valley, west-central Nepal, in December by Rand & Fleming (1957, p. 151).

*428. **Phoenicurus caeruleocephalus** (Vigors). Blueheaded Redstart.

After Hodgson's collection, Stevens's (1925a, p. 355) collection from the Singalila Range, eastern Nepal, at *c.* 3505 m., and Rand & Fleming's (1957, p. 151) from western to eastern Nepal, form the only records of the Blueheaded Redstart from that country.

429. **Phoenicurus ochruros rufiventris** (Vieillot). Eastern Black Redstart.

NEPAL VALLEY : Thankot : 1 ♀ (April 9).

The Eastern Black Redstart appeared to be rare indeed in Nepal, the above-mentioned specimen being the only one seen by us there.

Neither Scully (1879) nor Ripley (1950b) found it in Nepal. Proud (1949, p. 702; 1955, p. 60) observed very few in the Nepal Valley on passage in spring. In northern central Nepal it was reported in summer by Polunin (1955, p. 891) from *c.* 3350-4420 m. in the Langtang Valley, and by Lowndes (1955, p. 31) from *c.* 3655 m. in Manangbhot. Rand & Fleming (1957, p. 152) found it in the eastern Nepal tarai in winter.

Measurements : 1 ♀ : Wing 89 ; tail 65 ; bill 16.5.

430. **Phoenicurus hodgsoni** (Horsfield & Moore). Hodgson's Redstart.

DUN : Bhimphedi : 1 ♀ (March 13). NEPAL VALLEY : Kathmandu, Thankot : 6 ♂♂, 7 ♀♀, 1 (♀) (March 24—April 10).

Hodgson's Redstart is common in central Nepal, especially in the Valley where during March and the first half of April we found it on boulders in streams, on bushes about streams passing through forests and sometimes even in cultivated fields. It is, however, not so common in the dun.

Ripley (1950b) did not record it from Nepal. Rand & Fleming (1957, p. 152) reported it also from west-central Nepal at *c.* 915-2805 m. in winter.

All my birds had non-breeding gonads.

Colours of soft parts : Iris dark brown ; bill very dark horny to black, sometimes with yellowish on gape ; legs, feet and claws very dark horny to black ; pads grey, sometimes with a yellowish tinge.

Measurements :

	6 ♂♂	9 ♀♀
Wing :	84, 85 (3), 86, 87	81 (3), 82 (2), 82.5, 83[a], 84, 85
Tail :	68, 68+, 69 (3), 71	63, 65 (2), 66[a], 66 (2), 67, 68(2)
Bill :	16 (2), 16.5, 17 (3)	15.5[a], 16 (2), 16.5(5), 17

[a] Unsexed but (♀)

Baker (1924, p. 74) has given the measurements of tail and tarsus in this species as '66 to 68' and 'about 26', respectively. I measure them in 81 examples from all over its range as:

39 ♂♂ :	Tail	66—72 (av. 69.5),	tarsus	22—25 (av. 23.5)
42 ♀♀ :	,,	62—71 (av. 66.5),	,,	22—24 (av. 23.1)

431. **Phoenicurus frontalis** Vigors. Bluefronted Redstart.

Dun : Bhimphedi : 2 ♂♂, 1 ♀ (March 13, 14). Chitlang Valley : Chitlang : 1 ♀ (April 20). Nepal Valley : Thankot : 2 ♂♂, 1 ♀ (March 22-27).

The Bluefronted Redstart appeared to be a fairly common bird of central Nepal during March-April. It was usually seen perched on bushes in forests or open areas and on rocks, sometimes far away from water.

Ripley (1950b, p. 386) found it in eastern Nepal above *c.* 2440 m. in winter. In northern central Nepal, it was reported by Proud (1952a, p. 363) in the Gandak-Kosi watershed up to *c.* 3350 m. in spring, by Polunin (1955, p. 891) in the Langtang Valley at *c.* 3350 m. in summer, and by Lowndes (1955, p. 31) in Manangbhot at *c.* 3505-4570 m. in summer. Rand & Fleming (1957, p. 152) found it in west-central, central and eastern Nepal between *c.* 1370 and 2895 m. in winter. Biswas (1960a) observed it in central and eastern Nepal (Nepal Valley, Chautara, Ramechhāp and Okhaldhunga districts) between *c.* 1220 and 2440 m. in late January and early February, and between *c.* 3050 and 5335 m. in Khumbu during mid-February to May.

Measurements :

	Wing	Tail	Bill
4 ♂♂ :	86, 88, 90, 93	67, 71, 72, 76	15.5, 16 (2),—
3 ♀♀ :	82 (2), 86	64, 66, 68	15, 16 (2)

*432. **Phoenicurus schisticeps schisticeps** (J. E. & G. R. Gray). Whitethroated Redstart.

The Whitethroated Redstart was not found in Nepal either by Scully (1879) or by us. Ripley (1950b, p. 386) reported it from eastern Nepal at *c.* 2745 m. in winter; Lowndes (1955, p. 32) from Manangbhot, central Nepal, at *c.* 3050-3960 m. in summer; Rand & Fleming (1957, pp. 152-153) from west-central and eastern Nepal at *c.* 2745-3050 m.

in winter; and Biswas (1960a) from Khumbu, eastern Nepal, at *c.* 3810-4875 m. in March-May.

*433. **Phoenicurus erythrogaster grandis** (Gould). Güldenstädt's Redstart.

Rand & Fleming's (1957, p. 153) single specimen taken in the Kali Gandak Valley, west-central Nepal, at *c.* 2805 m. in winter, appears to be the only post-Hodgsonian record of the occurrence of Güldenstädt's Redstart in Nepal.

434. **Phoenicurus leucocephalus** Vigors. Whitecapped Redstart.

Bhabar : Amlekhganj : 1 ♀ (March 8). Nepal Valley : Thankot : 1 ♂, 1 ♀ (March 23, April 12).

During March-April we found the Whitecapped Redstart to be rather uncommon. It may be presumed that the majority of them must have already left by then for their breeding grounds.

From previous reports (Scully, 1879, p. 304; Smythies, 1948, p. 441; Proud, 1949, p. 702; Ripley, 1950b, p. 387; Polunin, 1955, p. 891; Lowndes, 1955, p. 32; Rand & Fleming, 1957, pp. 153-154; Biswas, 1960a) this species occurs in Nepal from west to east at *c.* 275-2590 m. in winter and spring, but higher up, up to *c.* 5335 m., in summer.

The forecrown is moulting in both my female specimens taken on March 8 and 23, the latter having nearly finished its moult.

Measurements :

	Wing	Tail	Bill
1 ♂ :	94	77	18.5
2 ♀♀ :	87+, 90	70 (2)	19 (2)

435. **Phoenicurus fuliginosus fuliginosus** Vigors. Plumbeous Redstart.

Dun : Bhimphedi : 1 ♂ (May 8). Markhu Valley : Kulikhani : 2 ♂♂, 1 ♀ (April 28). Chitlang Valley : Chitlang : 1 ♀ (March 15). Nepal Valley : Burhanilkantha : 1 ♂ (April 30).

The Plumbeous Redstart is not uncommon in central Nepal during March-April, but appears to be scarce in May. It is found wherever rapids and boulders occur in hill streams.

In northern central Nepal, Smythies (1948, p. 441) found a single example at *c.* 2440 m. in autumn; Polunin (1955, p. 891) occasionally observed it in the Langtang Valley at *c.* 3050-3655 mm. in summer; and Lowndes (1955, p. 32) found it up to *c.* 4420 m. in Manangbhot in summer. In west-central Nepal, it was reported only by Rand & Fleming (1957, p. 154) from the tarai up to *c.* 2440 m. in winter. In eastern Nepal, Ripley (1950b, p. 387) observed it in the Arun Valley between *c.* 305 and 1525 m. in winter, and Biswas (1960a) recorded it breeding at *c.* 3050 m. in Khumbu in May.

A male specimen taken April 30 had the testes but a little swollen, measuring R: 4.5×3, L: 5×3 mm.

Colours of soft parts : Iris brown ; bill black ; legs and feet dark horny ; claws black ; pads white.

Measurements :

	Wing	Tail	Bill
4 ♂♂ :	73.5, 76, 77, 78	50, 51, 54, 57	14, 15.5, 16, —,
2 ♀♀ :	68, 71	48, 50	14.5 (2)

436. **Hodgsonius phoenicuroides phoenicuroides** (J. E. & G. R. Gray).
Hodgson's Shortwing or Whitebellied Redstart.

Bhabar : Amlekhganj : 1 ♀ (March 6). Dun : Bhimphedi : 1 ♂, 1 subad. ♂, 1 imm. ♂ (May 5-7). Markhu Valley : Deorali : 2 imm. ♂♂, 2 ♀♀ (April 29-May 1). Chitlang Valley : Chitlang : 1 imm. ♂ (April 20). Nepal Valley : Thankot : 1 imm. ♂ (April 2).

This shortwing was occasionally observed by us in central Nepal. It appeared shy and always preferred dense bushes.

After Hodgson's collection, it was recorded only in the northern central Nepal in summer by Polunin (1955, p. 890) who found it occasionally at *c.* 3350 and 3960 m. in the Langtang Valley, and by Lowndes (1955, p. 31) who came across it at *c.* 2440 m. (once) and *c.* 3050-4420 m. in Manangbhot.

The subadult male specimen (May 5) is in olive plumage, the feathers of the nape and upper back having blue centres; upper tail coverts freshly grown and with rufous tips, chestnut on tail prominent: otherwise worn.

The immature males (April 2 – May 5) are also in olive plumage with traces of chestnut on lateral tail feathers, the one of May 5 being olive-brown with still reduced chestnut on rectrices. Those taken between April 20 and May 5 are moulting on the crown, chin and throat.

The female taken on May 1 has the feathers of the forehead tipped blue.

Measurements :

	Wing	Tail	Bill
2 ♂♂:	72[a], 74	77, 79[a]	18.5, 19[a]
3 ♀♀ :	69, 71, 71.5	76, 77, 78	18, 18.5 (2)

[a]Subadult

437. **Cinclidium leucurum** (Hodgson). Whitetailed Blue Robin.

Chitlang Valley : Chitlang : 5 ♂♂ (April 18-23). Nepal Valley : Thankot : 3 ♂♂ (April 7, 8).

The Whitetailed Blue Robin was found in small numbers by us only on the Chandragiri, both on Thankot and on Chitlang sides, in the forests near hill streams.

Scully (1879) did not record it from Nepal. Proud (1955, p. 60) found it breeding on Nagar Jong, Nepal Valley, at *c.* 2440 m. Stevens (1925a, p. 355) observed it in the Mai Valley, eastern Nepal, at *c.* 2440 m. in April.

It is curious that all the specimens collected by Ripley (1950b, p. 386) from Chitlang, and Rand & Fleming (1957, p. 154) from the Nepal Valley, are, like ours, males.

Measurements : 8 ♂♂ : Wing 94, 96, 96.5, 97(2), 98, —, 100 ; tail —, 78, 79, 80, 81, 82, 84, 85 ; bill 18, 19(4), 19.5, — (2).

*438. **Cinclidium frontale frontale** Blyth. Bluefronted Callene.

The only Nepali record of the Bluefronted Callene is based on Hodgson's collection (Horsfield & Moore, 1854, p. 396; Gray, 1863, p. 35; Sharpe, 1883, p. 15).

*439. **Grandala coelicolor** Hodgson. Hodgson's Grandala.

The post-Hodgsonian reports of the grandala from Nepal consist of two sight records, viz. Smythies's (1948, p. 441) from the Gandak-Kosi watershed, central Nepal, at *c.* 4570 m. in autumn, and Biswas's (1960a) from Khumbu, eastern Nepal, at *c.* 3655-3960 m. in mid-February.

*440. **Enicurus scouleri scouleri** Vigors. Little Forktail.

The Little Forktail was not found in Nepal by us or by Ripley (1950b). It was reported from central Nepal by Scully (1879, p. 311) in the Nepal Valley and Nawakot district; Smythies (1948, p. 441) observed a single specimen on Tadi Khola at *c.* 3655 m. in autumn; Proud (1949, p. 702) noted a few in the Nepal Valley in winter; and Polunin (1955, p. 890) reported it from the Langtang Valley at *c.* 2745-3350 m. in summer. In west-central Nepal, Rand & Fleming (1957, p. 154) found it in the Kali-Gandak Valley at *c.* 915 and 1525 m. in winter. Biswas (1960a) recorded it on Khimti Khola, Ramechhāp district, eastern Nepal, at *c.* 1830 m. in winter.

441. **Enicurus immaculatus** (Hodgson). Blackbacked Forktail.

BHABAR : Amlekhganj : 1 ♂, 2 subad. ♀♀ (March 8, 9). DUN : Hitaura : 1 ♂, 1 subad. ♂, 1 nestling (May 14, 29).

The Blackbacked Forktail was found by us in small numbers in central Nepal on streams between *c.* 305 and 610 m.

Scully (1879) did not record it in Nepal. Ripley (1950b, p. 386) found it from *c.* 305 to 1220 m. Rand & Fleming (1957, p. 154) reported it from west-central and eastern Nepal at *c.* 275-915 m. in winter.

While the adult male specimen of March 8 is in fresh plumage, the subadult female taken on the same day, has brown primaries and worn wing and tail, but fresh body plumage. Another subadult female collected on the next day has brown primaries, is otherwise in fresh plumage. Its crown and back are, however, brownish. The adult male taken on May 29 is very worn, as also the subadult male of the same day. This last example has brown primaries.

The nestling (May 14) has no white on forecrown, is sooty black on the upper side, has the wing patch, rump and upper tail coverts white. Its underside is downy white with traces of brownish spots on the breast and flanks.

Measurements :

	Wing	Tail	Bill
3 ♂♂ :	93, 93[a], 96	—[a], —, 124	20[a], 20, 20.5
2 ♀♀ :	89[a], 90[a]	—[a], 117[a]	20[a] (2)

[a] Subadult

*442. **Enicurus schistaceus** (Hodgson). Slatybacked Forktail.

Neither Ripley (1950b) nor we found the Slatybacked Forktail in Nepal. Scully (1879, p. 311) noted it as a resident bird of the Nepal Valley where Proud (1949, p. 702) also found it. Rand & Fleming (1957, p. 155) reported it from west-central Nepal at *c.* 915 m. in winter.

443. **Enicurus maculatus maculatus** (Vigors). Western Spotted Forktail.

Dun : Hitaura : 1 juv. ♂ (May 20). Nepal Valley : Thankot : 3 ♂♂, 1 subad. ♂, 3 ♀♀, 2 subad. ♀♀ (March 22—April 8).

The Western Spotted Forktail is not uncommon in the Nepal Valley during March-April. It occurs on the streams flowing down the hills round the Valley. We observed it also on the smaller streams in the forests of the dun.

Scully (1879, pp. 310-311) reported it from the Nepal Valley down to the dun. Proud (1949, p. 702) observed it in the Valley. Rand & Fleming (1957, p. 155) found it from western to central Nepal between *c.* 290 and 2285 m. in winter. Biswas (1960a) reported it from Chautara district, central Nepal, at *c.* 1830 m. in winter.

The subadult specimens are birds of the year, having brown primaries. The juvenile specimen is unspotted but with brown primaries.

Measurements :

	Wing	Tail	Bill
4 ♂♂ :	108, 109[a], 110, 111	146(2), 148, 150[a]	24[a], 24, 24.5, 25
5 ♀♀ :	99+[a], 101[a], 102, 103(2)	129(2), 134, 135[a], 139[a]	22.5[a], 23[a], 23(2), 24

[a] Subadult

As with Scully's (loc. cit.) and Rand & Fleming's (loc. cit.), my birds are also somewhat variable in regard to the amount of black and white. This variability prompted Scully to identify part of his collection as representing the eastern form *guttatus*. However, all those specimens had white crescents on the lower back, a characteristic of *maculatus*[1].

*444. **Enicurus maculatus guttatus** Gould. Eastern Spotted Forktail.

There appears to be only a single record of the Eastern Spotted Forktail from Nepal, that is, Stevens's (1924b, p. 68) from the extreme eastern Nepal in the Mai Valley at *c.* 2195 m. and lower.

445. **Cochoa purpurea** Hodgson. Purple Thrush.

DUN : Bhimphedi : 1 ♂ (May 10).

The only specimen of the Purple Thrush encountered by us in Nepal was in the dense forest east of Bhimphedi. It appeared very shy and was skulking in dense undergrowth. I believe, this is the first specimen of the species taken in Nepal since Hodgson's time. Ripley (1950b, p. 386) probably saw it at Bhimphedi, and Smythies (1950, p. 515) observed it once on Sheopuri Ridge, Nepal Valley, at *c.* 2135 m.

Measurements : 1 ♂ : Wing 142 ; tail 105 ; bill 24.

*446. **Cochoa viridis** Hodgson. Green Thrush.

The Green Thrush is known from Nepal only through Hodgson's original specimens (Gray & Gray, 1846, p. 96).

*447. **Saxicola insignis** J. E. & G. R. Gray. Hodgson's Bush Chat.

The only report of the occurrence of Hodgson's Bush Chat in Nepal is due to Hodgson's collection (Hodgson, 1844, p. 83; Gray & Gray, 1846, p. 71).

*448. **Saxicola torquata maura** (Pallas). Siberian Stone Chat.

The Siberian Stone Chat was not found by us. It has not been specifically mentioned in any Nepal list, but there are specimens of this subspecies in the British Museum from Nepal (ex Bailey collection). It is a winter visitor to Nepal and is so similar to the resident form (*indica*) in winter plumage as to be easily confused. It is quite likely that some of the winter records of *indica* refer to *maura*. Ripley (1961, p. 513) has included Nepal within the range of this form.

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[1] Vaurie (1959a, p. 419) states that *maculatus* 'grades into *guttatus* in central Nepal.'

449. **Saxicola torquata indica** (Blyth)[1]. Indian Stone Chat.

Dun : Hitaura, Bhimphedi : 1 ♂, 1 juv. ♂, 2 ♀♀, 1 juv. ♀ (March 11, 12, May 7, June 21). Chitlang Valley : Chitlang : 2 ♂♂, 1 ♀ (March 15, April 19, 23). Nepal Valley : Kathmandu, Godavari, Thankot : 9 ♂♂, 1 (♂), 4 ♀♀, 1 (♀) (March 23—April 12, May 10).

The Indian Stone Chat is common in central Nepal from the Valley down to the dun, singly or in pairs, in open country, cultivated land, scrub or rocky areas.

Ripley (1950b, p. 387) reported it from eastern Nepal. Polunin (1955, p. 890) found a single example in the Langtang Valley, central Nepal, at *c.* 4265 m. in summer. Rand & Fleming (1957, p. 156) recorded it from western to eastern Nepal.

The two juvenile specimens from Hitaura (June 21) are spotted, the male having in addition, the wing patch developed.

Some of my March and April birds were breeding, the earliest I have is dated March 12. A female was laying on March 23. The gonads of some March-April examples were in different stages of development.

Measurements :

	13 ♂♂	8 ♀♀
Wing :	64(2), 64[a], 65(2), 65.5, 66.5, 67(3). 67.5, 68, 68.5	62, 64, 64.5, 65, 65.5, 66, 69[a] (2)
Tail :	46, 47(2), 48(5), 48.5, 49(2), 49.5, 53[a]	44, 45, 45.5, 46.5, 47, 48.5, 49[a], 50[a]
Bill :	14(4), 14.5[a], 14.5(5), 15(3)	14(2), 14.5(2), 15(2) 15[a], 15.5[a]

[a] Sexed from plumage

450. **Saxicola torquata przewalskii** (Pleske). Turkestan Stone Chat.

Dun : Bhimphedi : 2 ♂♂, 1 ♀ (March 11, 12). Nepal Valley : Kathmandu, Thankot : 3 ♂♂, 3 ♀♀ (March 20, 29—April 11).

This stone chat is not uncommon in the Nepal Valley and the upper dun in open areas during spring. Like *maura*, this form is also a winter visitor to Nepal.

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[1] The type locality of this form was originally given as 'India' by Blyth (1847, p. 129). Baker (1921b, p. 709) restricted it first to Kashmir, and later (1924, p. 28) to Calcutta. The latter seems more reasonable because the Museum of the Asiatic Society of Bengal had specimens from the vicinity of Calcutta, but not from Kashmir, prior to 1847.

Scully (1879, pp. 300-301) rightly suspected that some of his specimens from the Nepal Valley (November to March) entered under *indica* were different from that form. Those specimens are in fact *przewalskii*. Rand & Fleming (1957, p. 156) found it in western, west-central and eastern Nepal.

Some of my specimens are wearing off to the summer plumage.

All my specimens had non-breeding gonads.

Measurements :

	Wing	Tail	Bill
5 ♂♂ :	71, 73(2), 74, 75	53, 54, 55, 56, 57,	16, 16.5(2), 17
4 ♀♀ :	71, 71.5(2), 72	51, 53(2), 54	16(2), 16.5, 17.5

*451. **Saxicola leucura** (Blyth). Whitetailed Stone Chat.

The sole record of the occurrence of the Whitetailed Stone Chat in Nepal is due to Rand & Fleming (1957, p. 156) who reported a single example from the western tarai in January.

452. **Saxicola caprata bicolor** Sykes. Indian Pied Bush Chat.

DUN : Hitaura : 1 ♂, 1 ♀ (May 27).

The Pied Bush Chat is not particularly common in central Nepal. Examples were seen by us from time to time in the dun in open areas such as cultivated fields about villages.

Scully (1879) did not find this species in Nepal. Ripley (1950b, p. 387) obtained specimens in the tarai of western Nepal only; Smythies (1950, p. 515) found it on Sheopuri Range, Nepal Valley; Polunin (1955, p. 890) reported it from the Langtang Valley, central Nepal, at *c.* 2135 m. in summer; and Proud (1955, p. 60) found only several examples on Sheopuri Range, Nepal Valley, and noted it to be common on the new road west of the Valley at *c.* 915 m. or lower. Rand & Fleming (1957, p. 157), however, recorded it in western, west-central and eastern Nepal between *c.* 275 and 1405 m. in winter.

Measurements :

	Wing	Tail	Bill
1 ♂ :	66+	50	15
1 ♀ :	68.5	50	15.5

453. **Saxicola ferrea ferrea** J. E. & G. R. Gray. Dark Grey Bush Chat.

MARKHU VALLEY : Deorali : 3 ♀♀ (April 29—May 1). CHITLANG VALLEY : Chitlang: 6 ♂♂, 2 ♀♀ (April 18—24). NEPAL VALLEY : Thankot, Crest of Chandragiri : 1 ♂, 2 ♀♀ (April 8—16).

The Dark Grey Bush Chat is common in the Nepal and Chitlang valleys in opener parts and about fringes of forests, on shrubs and lower branches of trees. It occurs singly, or in pairs or small parties.

In central Nepal, it was reported from the Nepal Valley by Scully (1879, p. 302), Proud (1949, p. 702; 1955, pp. 60-61), Smythies (1950, p. 515) and Rand & Fleming (1957, p. 157); from the Gandak-Kosi watershed at *c.* 3350 m. in autumn by Smythies (1948, p. 440); from Rapti Valley (Chisapani), Mahabharat Range, by Ripley (1950b, p. 387); from the Langtang Valley at *c.* 2745-3350 m. in summer by Polunin (1955, p. 890); from Manangbhot at *c.* 1830 m. in summer by Lowndes (1955, p. 31); and from Chautara district at *c.* 1830 m. in January by Biswas (1960a). Rand & Fleming (loc. cit.) recorded it also from western and west-central Nepal at *c.* 275-1405 m. in winter, and Biswas (loc. cit.) from eastern Nepal at *c.* 1525 m. in February and at *c.* 3050 m. towards the end of May.

It was breeding in April. Two females taken on April 15 and 16 had ovaries measuring 5.5×4 (with large granular ova) and 9.25×4.75 mm. (with 2.5 and 2 mm. ova), respectively.

Colours of soft parts : Iris dark brown ; bill, legs, feet and claws black ; pads grey.

Measurements :

	7 ♂♂	7 ♀♀
Wing :	67(3), 68, 69(3)	64.5, —(2), 66, 67(2), 68
Tail :	60, 61, 62(2), 64(2), 65	60, 62, 63(3), 64, 65
Bill :	15(2), 15.5(2), 16(2), —	15(3), 15.5(2), 16(2)

Kinnear (1934, p. 357), Stresemann (1940, p. 225), Mayr (1941, p. 220) and Ripley (1961, p. 516) suggested synonymizing the eastern subspecies *haringtoni* Hartert with the nominate subspecies, but Vaurie (1955b, p. 26) upheld them as separate races.

*454. **Saxicoloides fulicata cambaiensis** (Latham). Brownbacked Northern Indian Robin.

The post-Hodgsonian records of the Brownbacked Northern Indian Robin from Nepal have been provided by Ripley (1950b, p. 387) from the tarai (? western and/or central), and Rand & Fleming (1957, p. 157) from the western, west-central and eastern tarai.

[**Saxicoloides fulicata erythrura** (Lesson). Brownbacked Eastern Indian Robin.

Ripley (1950b, p. 387; 1961, p. 521) suggested that the birds from the eastern Nepal tarai might be *erythrura* which occurs in Bihar and West Bengal.]

455. **Monticola cinclorhynchus** (Vigors). Blueheaded Rock Thrush.

DUN : Bhimphedi : 1 ♀ (May 5). MARKHU VALLEY : Deorali, Kulikhani : 1 ♂, 1 ♀, 1 juv. ♀ (April 28, 29, July 2). NEPAL VALLEY : Thankot : 2 ♀♀ (April 13, 14).

The Blueheaded Rock Thrush is not a common bird of central Nepal. Examples were observed by us singly in dense bush or undergrowth in forests.

It is interesting to note that like ours all the previous post-Hodgsonian Nepali records of this species are from central Nepal, namely Nepal Valley (Scully, 1879, p. 283; Proud, 1949, p. 704, and 1955, p. 61; Ripley, 1950b, p. 389; Rand & Fleming, 1957, p. 158); Langtang Valley (Polunin, 1955, p. 891), and the dun (Ripley, loc. cit.).

My juvenile specimen is in spotted plumage.

Measurements :

	Wing	Tail	Bill
1 ♂ :	105	70	24.5
4 ♀♀ :	97, 97.5, 99, 101	65, 66(2), 66.5	24, 24.5(2), 26

Several recent authors (Meise, 1934, p. 43; Meinertzhagen, 1951, p. 456; Ripley, 1952, p. 36; Biswas, 1953, p. 47; Rand & Fleming, 1957, p. 158) considered this form as a subspecies of *Monticola gularis* (Swinhoe, 1862). However, I prefer to follow Vaurie (1955b, pp. 23-24) in treating them as separate species. Furthermore, even if they are considered conspecific, Vigors's name *cinclorhynchus* being older must be used as the specific name.

456. **Monticola rufiventris** (Jardine & Selby). Chestnutbellied Rock Thrush.

DUN : Bhimphedi : 1 ♂, 1 ♀ (March 12, 14). CHITLANG VALLEY : Chitlang, Chandragiri above Chitlang : 1 ♂, 3 ♀♀ (April 17-26). NEPAL VALLEY : Thankot, Crest of Chandragiri : 2 ♂♂, 2 subad. ♂♂, 1 ♀ (April 1-14).

This rock thrush is not uncommon in central Nepal in open parts or edges of forests where there are dense bushes, especially on Sheopuri Lekh, Phulchauki Danda, Chandragiri (both sides) and the Mahabharat Range.

Stevens (1925a, p. 361) reported it from the Mai Valley, eastern Nepal, breeding at *c.* 2135 m. upwards. In the Gandak-Kosi watershed, central Nepal, it was found at *c.* 3350 m. in autumn by Smythies (1948, p. 441) and at *c.* 2440 m. in spring by Proud (1952a, p. 363). Rand & Fleming (1957, p. 158) recorded it for west-central Nepal at *c.* 1405 m. in winter.

The two subadult specimens of mine are in worn plumage.

The species was breeding in April. A female taken on April 9 had a much enlarged ovary with the largest ovum measuring 3 mm. A male shot on April 14 had well-developed testes (R: 6×5, L: 8×4.5 mm.), and another female collected on April 21 had a 4.5×5.5 mm. ovary with large granular ova.

Colours of soft parts : Iris dark brown ; bill black but sometimes with greyish on the base of lower mandible ; legs, feet and claws very dark horny to black ; pads grey or yellowish grey.

Measurements :

	Wing	Tail	Bill
4 ♂♂ :	121.5+, 124, 126.5, 129	100(2), 101.5, 105	27(2), 27.5, 28
5 ♀♀ :	117, 118, 122(3)	96, 98+, 99, 100(2)	26, 27(3), 27.5

Meinertzhagen (1951, p. 457) followed by Biswas (1953, p. 47) placed this species as a race of *Monticola solitarius* (Linnaeus). They are, however, sympatric in a wide belt on the Himalayas, and indeed should be treated as distinct species.

*457. **Monticola solitarius pandoo** (Sykes). Indian Blue Rock Thrush.

We were not lucky enough to find this rock thrush in Nepal. Scully (1879, p. 282) noted it as a winter visitor to the Nepal Valley occurring in small numbers from October to early March. Ripley (1950b, p. 389) reported it from the tarai in winter. Lowndes (1955, p. 32) recorded it as a rare bird in Manangbhot, central Nepal, at *c.* 3655 m. in summer. Rand & Fleming (1957, p. 158) found it as an uncommon bird in the Kali Gandak Valley, west-central Nepal, in November.

458. **Myiophoneus[1] caeruleus temminckii** Vigors. Himalayan Whistling Thrush.

BHABAR : Amlekhganj : 1 ♂, 1 ♀ (March 7, 8). DUN : Hitaura, Bhimphedi : 2 ♂♂, 2 ♀♀, 1 subad. ♀ (May 10-31, June 10). CHITLANG VALLEY : Chitlang : 1 ♂ (March 18). NEPAL VALLEY : Burhanilkantha, Godavari, Thankot : 2 ♂♂, 2 ♀♀ (March 26, May 4-11).

The Whistling Thrush is a common bird of central Nepal on rivers and streams in or adjacent to forests, from the bhabar to the Nepal Valley.

It was recorded from western and west-central Nepal by Ripley (1950b, p. 390) and Rand & Fleming (1957, p. 159); from northern central Nepal by Proud (1952a, p. 364) in the Gandak-Kosi watershed up to *c.* 3505 m. in spring, by Polunin (1955, p. 891) in the Langtang Valley at *c.* 2745-4265 m. in summer, and by Lowndes (1955, p. 32) in Manangbhot up to *c.* 3655 m. in summer; from eastern Nepal by Stevens (1925a, p. 362) in the Mechi Valley at *c.* 2745 m. in February, and by Biswas (1960a) in the Dudh Kosi Valley at *c.* 1830 m. in early February and in Khumbu between *c.* 3050 and 5180 m. in March-May.

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[1] Vaurie (1959a, p. 415) has reverted back to the spelling *Myophonus*. It is true that on the explanation of pl. 170 of Temminck & Laugier's Planches color., livr. 29 (1822) the generic name is spelt as *Myophonus*, but two pages preceding it, where the genus is described, it is spelt as *Myiophoneus*.

The male specimen from Chitlang (March 18) lacks the white tips of the median wing coverts.

The subadult female specimen from Hitaura (June 10), which had fully breeding ovary (with ova as large as 3 – 5 mm.), is somewhat duller in general coloration, the glistening spots are duller and smaller, and the white tips of the median wing coverts dull white. It is, moreover, smaller in size.

Birds taken in March had the gonads just commencing to enlarge, while those of May were more or less in breeding condition.

Colours of soft parts : Iris dark brown ; upper mandible dusky yellow (yellow in the subadult specimen) with blackish on base and culmen, and dark horny tip ; lower mandible yellow ; legs, feet and claws black, pads yellowish grey.

Measurements :

	6 ♂♂	6 ♀♀
Wing :	167+, 169, 173, 175(2), 184	160, 162, 164, 165, 167, 168+
Tail :	129, —(2), 136, 138, 140	120(2), 121, —, 123, 127
Bill :	33, 33.5, 35(2), 36(2)	33(2), 34(2), 35(2)

The tail length 116 – 122 as given by Baker (1924, p. 180) is much too small. Delacour (1942, p. 256) has given it up to 141, with which I agree.

459. **Zoothera wardii** (Blyth). Pied Ground Thrush.

CHITLANG VALLEY : Chitlang : 1 subad. ♂ (April 25).

The above-mentioned specimen of the Pied Ground Thrush was the only example of the species observed by us in Nepal, and this incidentally appears to be the only post-Hodgsonian record from that country.

The specimen appears to be a first-year bird. Some feathers of its nape, mantle, lower back and rump are olive brown; primaries brown, median wing coverts tipped rufous, and there are a few black bars on the white of lower breast.

Measurements : 1 subad. ♂ : Wing 113 ; tail 76 ; bill 26.5.

460. **Zoothera citrina citrina** (Latham). Orangeheaded Ground Thrush.

DUN : Hitaura, Bhimphedi : 6 ♂♂, 1 ♀ (May 3-17, June 18, 21). NEPAL VALLEY : Thankot : 3 ♂♂, 1 (♂), 3 ♀♀, 1 (♀) (March 22—April 8).

The Orangeheaded Ground Thrush is common in central Nepal in dense undergrowths and bushes, usually feeding on the ground.

It was reported from the Nepal Valley only in summer by Scully (1879, p. 283) and Proud (1949, p. 703). Although Ripley (1950b, p. 389) did not find it in the tarai in winter, Rand & Fleming (1957, p. 159) reported it to be fairly common there in December and February.

March birds are in quite fresh plumage. A few of my May specimens and both the June ones are very worn.

It was breeding in May.

Colours of soft parts : Iris dark brown ; bill very dark horny to black sometimes with greyish on gape, base and sides of lower mandible ; legs fleshy with brownish front or light horny brown with yellowish behind ; feet fleshy to light horny brown ; claws fleshy to horny ; pads fleshy or yellowish fleshy.

Measurements :

	10 ♂♂	5 ♀♀
Wing :	116+, 118, 118+, —(2), 119(2), 120(2), 121	117(2), 120, 121+, 123
Tail :	75, 76, 78, 79, 80(2), 82(3), 83	76, 78, 79(2), 81
Bill :	23, 23.5(2), 24(6), 25	23, —, 24, 24.5, 25

Baker (1924, p. 149) has given 67-69 mm. as the tail length in the male, which is, however, much too small. Fifty-two specimens measure as follows:

37 ♂♂ :	72-83 (av. 76.5) (once 68)	15 ♀♀ :	72-81 (av. 75.9) (once 69.5)

461. **Zoothera mollissima mollissima** (Blyth). Eastern Plainbacked Mountain Thrush.

NEPAL VALLEY : Thankot : 1 ♀ (April 6).

The above-mentioned specimen was the only example of the Plainbacked Mountain Thrush observed by us in central Nepal. It was found in dense forest on the Chandragiri Range above Thankot at about 1830 m.

Neither Scully (1879) nor Ripley (1950b) noticed it in Nepal. Stevens (1925a, p. 362) reported it from the Mai Valley, eastern Nepal, at *c.* 2135-2240 m. in March-April. Smythies (1950, p. 515) saw it (or ? *Z. dauma*) only once on Sheopuri, Nepal Valley. Proud (1955, p. 61) found it common in the Nepal Valley at *c.* 2440 m. (occasionally at *c.* 1525 m.) in winter. Rand & Fleming (1957, pp. 159-160) obtained a single example on the Phulchauki Danda, Nepal Valley, at *c.* 1890 m. in February. Biswas (1960a) found it in Khumbu, eastern Nepal, at *c.* 3655 m. in April.

Measurements : 1 ♀ : Wing 134; tail 90; bill 26.

The size of the tail, 100-130 mm., as given by Baker (1924, p. 163) is indeed much too large for this species. Vaurie (1955a, pp. 2-3) has, however, given correct measurements of specimens studied by him.

As Vaurie (op. cit., p. 7) has pointed out, the specimen under report is indeterminate as to subspecies. However, since Rand & Fleming (loc. cit.) found that Kumaon, Nepal and Sikkim (virtually topotypical *mollissima*) birds are inseparable, I am listing my specimen under the nominate race. I agree with Vaurie (op. cit., p. 6) that *simlaensis* Baker is best treated as a synonym of *whiteheadi* Baker (see also Ripley, 1961, p. 528).

*462. **Zoothera dixoni** (Seebohm). Longtailed Plainbacked Mountain Thrush.

Geokichla dixoni Seebohm, 1881, Catal. Birds Brit. Mus. **5** : 161. (Himalayas; lists specimens from Nepal and Darjiling ; type locality hereby restricted to Darjeeling subdivision, West Bengal.)

This mountain Thrush was not found by us or by Scully (1879) in Nepal. Smythies (1948, p. 441) observed it in the Gandak-Kosi watershed, central Nepal, at *c.* 3505 m. in autumn. Ripley (1950b, p. 389) obtained a single example in the Arun Valley, eastern Nepal, at *c.* 2745 m. in February. Rand & Fleming (1957, p. 160) reported a single specimen from the Nepal Valley at *c.* 1675 m. in January.

463. **Zoothera dauma dauma** (Latham). Smallbilled Mountain Thrush.

Turdus dauma Latham, 1790, Index Orn. **1**: 362. (India = Kashmir, according to Baker, 1921b, p. 720.)

BHABAR: Amlekhganj: 1 ♂, 1 unsexed (March 9, 10). DUN: Bhimphedi: 1 ♀ (May 4). MARKHU VALLEY : Deorali : 2 ♀♀ (April 28, 30). CHITLANG VALLEY : Chitlang : 2 ♂♂ (April 17, 19). NEPAL VALLEY : Thankot, Crest of Chandragiri : 6 ♂♂, 2 ♀♀, 1 unsexed (March 22—April 16).

The Smallbilled Mountain Thrush is common in central Nepal usually in dense forests or grassy clearings in or near forests. In the bhabar it was not found by us as common in March, the majority having evidently left for the breeding ground. On the hills around the Nepal Valley, on the Chitlang side of the Chandragiri, and on the Mahabharat Range (both on the southern and northern sides), it was frequently seen from about the middle of March, usually in pairs.

Scully (1879, p. 286) noted it to be rare in the Nepal Valley occurring 'probably only' on passage. Smythies (1950, p. 515) saw it (or ? *Z. mollissima*) only once on Sheopuri Range, Nepal Valley. Proud (1952a, p. 363) found a single example in the Gandak-Kosi watershed, central Nepal, at *c.* 2590 m. in March. Rand & Fleming (1957, p. 160) reported it common in the lowlands of western, west-central and eastern Nepal in winter, and recorded a specimen from the Nepal Valley at *c.* 1675 m. in January.

Specimens taken in mid-April had the gonads already enlarged to some extent.

Colours of soft parts : Iris very dark brown ; upper mandible horny black ; lower mandible pale brownish yellow on base, whitish on the middle, gradually turning horny anteriorly until the tip is horny black ; legs and feet pale horny brown ; claws pale horny, much paler on the tips ; pads yellowish white.

Measurements :

	9 ♂♂	5 ♀♀	2 unsexed
Wing :	142, 142+, 143, 144, 145, 147(2), 147.5, 148	138, 139, 141.5, 143(2)	143, 144
Tail :	95, 98, 101, 102, 104, 105(2), 106, 107	97, 98, 100, 102, —	103, 105
Bill :	27.5, 28(3), 29, 29.5, —(2), 31.	28, 28.5, 29(2), —	28, 30

464. **Zoothera monticola monticola** (Vigors). Large Brown Thrush.

Zoothera monticola Vigors, 1830-31 (1832), *Proc. zool. Soc. Lond.* (1) : 172. (Himalayas=Sikkim, according to Baker, 1921b. p. 721.)

Nepal Valley : Thankot : 1 ♂ (April 5).

The Large Brown Thrush is apparently very rare in Nepal. The only specimen that we came across was collected in dense undergrowth of the forest at Thankot.

Scully (1879) and Ripley (1950b) did not record it from Nepal, but Rand & Fleming (1957, pp. 160-161) reported a single specimen from western Nepal at *c*. 305 m. in January.

Measurements : 1 ♂ : Wing 145; tail 85+; bill 44.

465. **Zoothera marginata** Blyth. Lesser Brown Thrush.

Bhabar : Amlekhganj : 1 ♀ (March 8). Dun : Bhimphedi : 1 ♂, 1 ♀ (May 5, 10).

This thrush appeared rare indeed in central Nepal. It was observed by us only on a few occasions in dense undergrowths in the forests of the bhabar in spring and the upper dun in summer. The species has recently been recorded for the first time from Nepal by Rand & Fleming (1957, p. 161) who obtained a single example from the western part of the country at *c*. 290 m. in January.

My male specimen (May 5) is moulting on the crown, but its wings are worn.

Measurements : 2 ♀♀ : Wing 126, 129 ; tail 76, 78; bill 34,—.

[Scully's (1879, p. 284) record of the Blackbreasted Thrush, *Turdus dissimilis* Blyth, from the Nepal Valley, was probably due to misidentification of his specimen. No such example was received from Scully at the British Museum (Seebohm, 1881, p. 266) or the Indian Museum, nor has the species ever been known from west of Assam and lower East Pakistan.]

466. **Turdus unicolor** Tickell. Tickell's Thrush.

Chitlang Valley : Chitlang : 5 ♂♂, 2 subad. ♂♂, 3 ♀♀ (April 18-25).

Tickell's Thrush is occasionally found in the Nepal, Chitlang and Markhu valleys from about the end of March. It usually occurs on the edges of forests in pairs or in small feeding parties.

Rand & Fleming (1957, p. 161) reported it also from west-central Nepal at *c.* 1430 m. in November.

Measurements :

	Wing	Tail	Bill
5 ♂♂ :	124 (4), 128	86, 87, 88, 90 (2)	23 (3), 23.5,—
3 ♀♀ :	119+, 120 (2)	—, 84, 85	23, 23.5, 24

467. **Turdus albocinctus** Royle. Whitecollared Blackbird.

Chitlang Valley : Chitlang : 1 ♀ (March 15). Nepal Valley : Thankot 1 ♀ (March 22).

The Whitecollared Blackbird occurs singly on moss-covered branches of trees on Chandragiri both above Thankot and above Chitlang from *c.* 1525 to 2135 m., and on the Phulchauki Danda above Godavari. It does not appear to be common.

It was reported as a winter visitor to the Nepal Valley (Scully, 1879, p. 286), leaving early in April (Proud, 1955, p. 61). Rand & Fleming (1957, p. 161) found it also in eastern Nepal at *c.* 3050 m. in winter. Ripley (1950b) failed to notice it in Nepal.

My Thankot specimen is somewhat lighter coloured both above and below.

Measurements : 2 ♀♀ : Wing 137, 140 ; tail 108, 111 ; bill 29, 30.

468. **Turdus boulboul** (Latham). Greywinged Blackbird.

Tarai : Simra : 2 ♀♀ (March 5). Markhu Valley : Deorali : 1 ♂ (May 3). Chitlang Valley : Chitlang : 2 ♂♂, 1 ♀ (April 16-20). Nepal Valley : Thankot, Crest of Chandragiri : 3 ♂♂, 1 ♀ (April 4-18).

The Greywinged Blackbird is common in the forests of central Nepal above the dun from April onwards. In the dun and tarai only a few examples were observed by us in early March.

In western and west-central Nepal, Rand & Fleming (1957, pp. 161-162) reported it from *c.* 275 m. up to 1980 m. in winter. In northern central Nepal, Proud (1952a, p. 363) noted it as common up to *c.* 2745 m. in the Gandak-Kosi watershed during spring. In eastern Nepal, Stevens (1925a, pp. 359-360) recorded it from the Mai Valley up to *c.* 2745 m. in March-April, and Biswas (1960a) found it around 2745 m. in the Hongu Valley in June.

Of the two specimens taken on March 5, one is in very fresh plumage, while the other is worn all over. Two specimens taken April 16 and 20 are in fresh plumage, the one of April 16 has, however, slightly worn body feathers. The remaining four birds taken between April 13 and 20 are in more or less worn plumage. The May 3 bird has fresh wings and worn body plumage.

A female taken on April 17 was laying, and a male of April 18 had breeding testes.

Colours of soft parts: Iris brown; eyelids lemon yellow; bill orange with dark horny on the tip of upper mandible; legs, feet and claws brownish yellow, pads yellow.

Measurements:

	Wing	Tail	Bill
6 ♂♂:	141 (2), 142, 143+, 144, 148	110+, 111+, 114, 116 (2), 116+	27 (3), 27.5, 28,—
4 ♀♀:	136, 138, 142, 148	100+, 110, 111 (2)	25.5, 26.5 (2), 28

469. **Turdus rubrocanus rubrocanus** J. E. & G. R. Gray. Western Greyheaded Thrush.

Turdus rubrocanus J. E. & G. R. Gray, 1846, Catal. spec. drawings Mam. Birds Nepal Thibet pres. Hodgson, p. 81 (Nepal), *nomen nudum*, but validated by Copenhagen Decision 115 (2).

DUN: Bhimphedi: 1 ♂ (March 12). NEPAL VALLEY: Tankot: 1 ♂ (March 28).

The Greyheaded Thrush is quite uncommon in central Nepal. We observed it only on a few occasions when it occurred singly in dense forests.

Scully (1879, p. 286) did not come across it. Ripley (1950b, p. 389) recorded it by sight only in eastern Nepal. Proud (1955, p. 61) reported it as very uncommon in the Nepal Valley, but common on hills north of Pokhara, west-central Nepal. Rand & Fleming (1957, p. 162) secured a single example in the Nepal Valley (Nagar Jong, ♀, February).

My specimen from Bhimphedi is worn.

Measurements: 2 ♂♂: Wing 138, 138+; tail 106+, 107; bill 28, 29.

Baker (1924, p. 133) mentions a specimen also of the eastern race *T. r. gouldiae* (Verreaux) from Nepal in the British Museum.

*470. **Turdus obscurus** Gmelin. Dark Thrush.

The only Nepali record of the Dark Thrush is based on a single skin in the Hodgson Collection, not listed by Gray & Gray (1846) or Gray (1863), but reported by Stevens (1925a, p. 360).

471. **Turdus ruficollis atrogularis** Jarocki. Blackthroated Thrush.

TARAI: Simra: 1 ♀ (March 6). CHITLANG VALLEY: Chitlang: 1 ♂ (April 17). NEPAL VALLEY: Kathmandu, Thankot: 3 ♂♂, 3 ♀♀, 1 unsexed (March 20—April 2).

The Blackthroated Thrush is quite common in central Nepal during March-April. It occurs in pairs or flocks of varying sizes, three to twenty or so, about cultivation, grasslands, edges of forests, etc.

Rand & Fleming (1957, p. 162) reported it also from west-central and eastern Nepal at *c.* 915-3810 m. in winter. Biswas (1960a) found it in Khumbu, eastern Nepal, at *c.* 3960 m. in March.

One of my male specimens taken April 17 is somewhat worn.

The gonads of this specimen had just started swelling. Two female birds (March 23 and 27) had finely granular ovaries.

Colours of soft parts : Iris dark brown ; upper mandible dark horny with yellow on gape and sides ; lower mandible yellow with dark horny tip ; legs yellowish or brownish grey with dusky front ; feet yellowish grey to horny brown ; claws horny or dark horny : pads white.

Measurements :

	Wing	Tail	Bill
4 ♂♂ :	131, 133, 134, 137	95 (2), 96, 100	24, —(2), 25
4 ♀♀ :	129, 131 (2), 134	—, 95, 96, 97	22.5, 23.5, 24, 24.5
1 unsexed :	130	96	23

*472. **Turdus naumanni eunomus** Temminck. Dusky Thrush.

The only post-Hodgsonian report of the Dusky Thrush from Nepal is due to Proud (1949, p. 703) who found it in the Nepal Valley on Nagar Jong at *c.* 1525 m. in winter and spring.

*473. **Turdus viscivorus bonapartei** Cabanis. Himalayan Missel Thrush.

The only record of the occurrence of the Himalayan Missel Thrush in Nepal appears to be based on the single skin in the British Museum *ex* Hodgson collection (Seebohm, 1881, p. 196).

(*To be continued*)

Chapters on the History of Botany in India

III: AT THE MIDDLE OF THE 19TH CENTURY

BY

I. H. BURKILL

[*Continued from Vol.* **54** (1) : 86]

My reader will readily consent that India made such economic progress at the middle of the 19th century that Botany could not escape its influence. A great unification was effected by a vast network of roads; the electric telegraph came (1851). From 1850 forwards railways were under construction. Parochialism receded. The interests of the majority were widened. As to the botanists, with whom we are concerned, he among them with a little leave to take could use it for enlarging his experience, and was not long in doing so. I will begin the chapter by recalling the names of the botanists who worked in India at the middle of the century.

The East India Company never engaged in Britain any officer expressly for what he knew of Botany; when they wanted a botanist they sought him among their officers already in India. It was otherwise in the manner of appointments for service in Ceylon, as Ceylon had no deep well to dip into, and in consequence only such men as the *ad interim* holders of the post of superintending the Peradeniya Garden on the death of Moon and the death of Gardner were found locally. Frazer, acting in Ceylon when Gardner died, seems to have collected a little. The Company's procedure, unlike that of Ceylon, left room for the chosen to have had time to grow a little rusty. And in 1854, as if in anticipation of the coming administrative changes and in step with the passing out of British politics of a conviction that *laissez faire* led to progress, the Court of Directors accepted the planning of education as a duty. But the acceptance of the duty did not press on the Directors, for their authority was swept away too soon. Nothing came; but there was an increase in the number of those who botanized which must be attributed to diffusion of interest in botany in Britain in the stratum of the population whence came those who served in India.

Our science had been, as it were, an unexplored country into which a route is first made and names are given to landmarks; successive explorers perpetuate them. The route is marked on the maps along with the places on it suitable for rest and refreshment. Branch routes take off at these; their rate of establishment, like elongation of the main road itself, depending on the terrain penetrated. Into the kingdom of scientific Botany the main route is that of taxonomy; the landmarks are genera and species; the places of rest and refreshment are Botanic Gardens, Museums, Learned Societies, and the like; the branch roads are the several divisions into which the science has fallen, and the development of some may have been hindered for tools such as the microscope to be improved, adjuncts such as laboratories to be built, and data to be accumulated.

The resemblances are so close to reality that the facts recorded in the next three sections are arranged on the analogy.

The Botanists whose Activities connect the Second Chapter with this Chapter

Wight left India in 1855. For the last few years he had been occupied in winding up his affairs. The Coimbatore Experimental Farm had to be left so shaped that his successor could use it. He seems to have ceased to collect and dry plants; at any rate he left no collections from the Anaimalai Hills (*teste* C. E. C. Fischer in *Rec. Bot. Survey Ind.* **9** : 5) from which Coimbatore is only 26 miles distant. Apparently his collections were already in packing cases when the call came to close down; they had filled 10 bullock carts at the last move and would be larger than in 1850. Of his serial publications he closed these two: ILLUSTRATIONS OF INDIAN BOTANY in 1850 and SPICILEGIUM NEELGHERRENSE in 1851. He did not close down his ICONES PLANTARUM INDIAE ORIENTALIS; and a part was added after he had reached London, where also a report on cotton was finished and published.

Wight, who had learned the art of lithography in the house of Sir William Hooker when on leave in Britain, was now back in Britain and in contact with Sir William Hooker, whose resources for naming plants he could use; and Kew was ready to distribute his duplicate botanical specimens. Wight had dominated botanical work in India so greatly that his departure was a major event by which the period changed. In some measure the leadership on his going passed to H. F. C. Cleghorn.

Hugh Francis Clarke Cleghorn (1820-1895) was a grandson of Hugh Francis Cleghorn who, as recorded in the second chapter (*Journal* **54** : 49), engaged Rottler to accompany him as interpreter on an inspection tour in Ceylon. He had been born in Madras and had taken a doctorate in medicine in Edinburgh. Having returned to India he was sent to Shimoga in Mysore as Civil Surgeon (1842). The teak forests of the district interested him; and in 1847 he called attention to the waste of timber caused by the way in which the land was exploited. In 1850, being on leave, he laid his case before the British Association which was meeting in Edinburgh and the Association appointed a Committee, of which he was secretary, to report back in 1851. In 1852, having returned to India, he found himself no longer a district surgeon, but a professor of Botany and Materia Medica in the College at Madras. There, from a position, which entitled him to a hearing, he addressed the Government (1856) and in 1857 he was taken from his teaching to occupy a new post, the post of Conservator of Forests. The reader notes the implication of caring for more than teak in the title of his post; there was in view wood-fuel, of all sorts; but teak-timber was most in view. From 1857 to his retirement in 1870 Cleghorn was occupied in Forest Service, and even afterwards as an adviser of the India Office. More about Cleghorn will be found later.

The reader doubtless appreciates the fact that Cleghorn came to his forest service as a botanist. He had previously collected dried plants which were given to the Calcutta Garden and he had written ecological papers. Contemporaries there were who were connected with conserving teak, but they were not botanists; they were practical men; and the association of these with botanists was merely provisional. One of these practical men was **H. A. Conolly,** Collector of the district of Malabar, where the teak forests had received the most damaging exploitation. He had asked to be allowed to buy up and replant ruined teak forest, and had great success in restocking, particularly in the Nilambur forest which is ideal for teak. Nilambur is half-way between Calicut and Ootacamund. Of course restocking, with cropping about 100 years ahead, does not allow Conolly's financial questions a place here; but Conolly showed himself a pioneer.

While he was doing what he had undertaken, Captain **Frederic Cotton,** an engineer, was making a road along the border of the State of Cochin; and he called attention to the teak that he saw in the Anaimalai Hills—teak which Wight might have seen by going into the Hills from Coimbatore. Cotton's teak was put (1850) into the charge of another army officer, **James Michael,** then a lieutenant, ultimately a general. He held his charge until 1856, and did a little collecting of plants; but very little. In 1856 he was succeeded by one who was already a botanist, R. H. Beddome. It is to be noted that the year of Beddome's appointment is the year of the appointment of Cleghorn as Conservator of Forests; and that 1857 seems to have been a year of thinking ahead—a Forest Service was coming in Madras. In its foreshadowing is the third of the marks of our new period.

Michael in due time took leave and did not re-enter the Forest Administration, though he kept his interest in forestry through life. In the Anaimalai Hills he had tried to minimize the injury that fire did to his seedlings of teak by causing the coating of dying leaves that fell on them to be swept aside.

Richard Henry Beddome (1830-1911) had reached Jabalpur in 1848 and had commenced collecting there. The Government of Madras, when in 1856 it took him into the initial Forest Service, employed him in the Palni Hills, where he picked up Wight's mantle in one respect, namely the illustrating of the plants of southern India by the use of lithography. He threw himself with great energy into collecting and made a considerable herbarium. He learned his forestry by experience, but was all through his life predominantly a botanist.

I have classified Cleghorn as an ecologist, calling him the second ecologist that India had, the first having been Edgeworth. Both were Edinburgh students, but it is not clear that their interest had a common origin, though it is apparent that ecology was, so to speak, in the air at Edinburgh. **John Hutton Balfour** (1808-1884) introduced a little of it into his professorial teaching; and, though he had not become professor until 1845, he had given extra-mural lectures in Edinburgh some ten years earlier. I suggest that this vigorous teacher, whose classes were described as 'thronged' and as 'the largest ever brought together', forced the contemplation of the life of the plant into the teaching of his time; whereas Robert Graham, his predecessor, by making his students carry pocket lenses on their expeditions with him into the country, forced observation of the details of the flower into the teaching.

Wight, Michael, Cleghorn, and Beddome are not the only botanical names of the Madras collections of about the fifties: these also served: **Heber Drury** (1819-1872), a colonel in the Madras Army was in Travancore; **Sir Walter Elliot** (1813-1887), an administrator of wide interests, was at Vizagapatam; **Thomas Caverhill Jerdon** (1811-1872), who made his reputation as a zoologist but also collected plants, was in the southern part of the Presidency until 1868; **Gideon Thomson** (see Chapter 2, *Journal* **54** : 83) was collecting there until 1855; a missionary, **E. Johnston,** was a rather discriminating collector of the south-western coasts; where also was another, **Samuel Mateer** (1835-1893), who paid attention in particular to the vernacular plant-names that he encountered. There were two horticulturists in the Presidency who did excellent work in their own line, **Andrew T. Jaffray** and **William Graham McIvor,** the first at Madras, the second in the Nilgiri Hills at Ootacamund. The zoologist Jerdon made excursions into Botany and the botanist Beddome made excursions into Zoology.

As Ceylon at this date hung on to Madras by accepting the guidance that Wight gave, it is convenient at this point to look southward to it. General Warren Walker had protested that the Peradeniya Garden was in the charge of 'an ignoramus who could not read the language of Botany'. This was James George Watson (for whom see page 50 of the second chapter), and the General's protest had borne fruit at Watson's death, when Sir William Hooker had been able to get his former pupil, the surgeon **George Gardner,** accepted. **Sir James Emerson Tennent** was the Colonial Secretary; and between him and Gardner a friendship arose which led to companionship; one may say that the Botany in Tennent's account of Ceylon had been talked over with Gardner in joint rambles. It was during the years of this friendship that the German surgeon Warner Hoffmeister reached Ceylon (see the second chapter, *Journal* **54** : 50). Neither he nor Prince Waldemar of Prussia, with whom he was travelling, saw Gardner who was away from Peradeniya at the time. Hoffmeister wrote that Gardner was the only botanist in Ceylon; but this overlooks amateurs who were there; and the meaning of Hoffmeister's words must have been that Gardner was officially the only botanist. Another officer of the General's name, Colonel **James Thomas Walker,** collected plants in Ceylon between 1830 and 1840.

William Ferguson (1820-1887), by profession a surveyor, was in Colombo. It is not quite sure when his interest in ferns developed; but he assuredly was already interested in economic plants from his arrival in 1839. He was a man of great ability and activity.

Harmanis De Alwis, the splendid artist of the Peradeniya Garden, has a large claim for attention. He came on to Moon's staff as a clerk and Moon, discovering his talent, paid for his training as a flower-painter. He served from 1823 to 1861 and a son succeeded him.

Gardner on assuming charge, commenced work exactly as General Walker would have wished, i.e. by collecting vigorously. He had his artist to draw for him, and it is to be noted that perishable fungi received his attention but to be regretted that from want of direction these drawings, in Petch's opinion, are impressions rather than portraits.

Unfortunately Gardner's death came suddenly in 1849, when the Colonial Office appointed an equally efficient man G. H. K. Thwaites to succeed him and we find this new man in the last days of that year climbing the road from Colombo to Kandy to assume charge.

George Henry Kendrick Thwaites (1811-1882) was probably the most liberal-minded botanist then in the East. As a young man, earning his living by accountancy, he employed his leisure to very good effect in studying the lowest plants; then he became a teacher himself in the School of Pharmacy at Bristol and in succession to this in the Medical School. From Bristol he applied for a teaching post in Ireland; but he did not get it, though his sponsors were among the most prominent botanists in Britain and France. The reader, noting this, is made sure of the competence to which Thwaites had brought himself. Instead of the post in Ireland he was appointed to succeed Gardner in Ceylon. Thwaites in detail did so; as he climbed the road to Kandy he moved exactly into the work of Gardner, the work that General Walker had wanted; he became a student of the Flowering Plants of the island. The study of the Lower Plants was for those whom he could induce to work on what he would collect. **William Mitten** worked up his mosses, **W. A. Leighton** his lichens, and **Miles Berkeley** his fungi. Berkeley took **Christopher Edmund Broome** for a fellow worker and between them they carried the knowledge of the fungus flora of Ceylon a vast way beyond that of India. Thwaites could not have done better.

Let it be stressed here that Gardner had set the example of collecting the fungi.

Gardner seems to have brought a large personal herbarium to Ceylon and to have amalgamated it with the collection started by Moon. The amalgamation had to be undone so that Gardner's property could be sold for the benefit of his family. With that done the growth of the herbarium became the work of Thwaites. Neither Berkeley nor Broome visited Ceylon, and the species which they named were those collected by Thwaites. A biographer credits Thwaites with being 'a naturalist, pure and simple, a keen and accurate observer of great industry, quietly enthusiastic and with great reasoning capabilities'. Broome had known him when resident in Bristol. Berkeley and Broome co-operated with equally great and equally quiet enthusiasm; in fact they isolated themselves.

William Ferguson (1820-1887), by training as surveyor, in Ceylon from 1839 until his death, developed, as already said, an interest in economic plants and in ferns; and he took an interest also in the seaweeds.

Thwaites used Wallich's way of getting help from Europe, the way of liberality, of distributing specimens in the hope of obtaining determinations; he made up sets of dried plants which were given where a return was expected, and were on sale also. His greatest help came from Kew, where Sir Joseph Hooker would compare the Ceylon with Indian plants. Thwaites's ENUMERATIO PLANTARUM ZEYLANIAE CATALOGUS (1858) was made on the materials that went into his sets.

The Colonial Government had been caused to transfer their botanical work from the coast to the hills by the rush into the coffee districts of would-be planters, many of them agriculturally ignorant and all in need of guidance, which they came to expect but did not particularly go to seek. Thwaites seems to have been left in his first years to find his feet. In 1854 came what Sir Emerson Tennent, the Colonial Secretary, described in his CEYLON (**2** : 211) as 'a murmur of ill-informed utilitarianism against the expenditure bestowed on the Botanic Garden and a proposal that the Garden be abandoned'. Tennent shows that official opinion supported Thwaites; and Ferguson took a leading part in upholding him; but Thwaites as a consequence had more economic work thrown on him, while the preparation of the ENUMERATIO was still in progress for yet another few years.

The following also botanized in Ceylon at this time: a chaplain, **John Gibson MacVicar,** just before 1850, and apparently the judge, **Sir William Norris,** in the period before he was transferred to Penang (1836). That these two were actual collectors of Ceylon plants is not certain; both may have developed collecting as a pastime after leaving Ceylon. **Edward Frederick Kelaart** (1818-1850) was born in Ceylon, but most of his botanical work was done elsewhere; and he was more interested in zoology than botany.

Neitner, a German biologist, made a stay in the island (1854-1855) and took a collection to Berlin.

It is time to turn northwards to the Bombay Presidency. **John Graham** had died in 1839. **Charles Lush** and **Joseph Nimmo** had died in 1854. A fourth botanist of Bombay of those years was lost to Bombay—Captain **Henry Geburne,** an Artillery officer, who left by retirement (1846). **John Sutherland Law** remained as the doyen, but not for long. He knew the plants of the districts in which he had served; but he published little. Four years after the year in which this chapter begins he also retired, taking with him a herbarium of about 1500 species, part of which went to Oxford and the rest to Kew.

When Law left India, the leadership in Bombay passed to **Alexander Gibson** who had been in charge of the Dapuri Garden in Poona from 1836 to 1847 and had published thence several not unimportant papers on economic plants including one on the Teak tree (1840). In 1847 he was appointed Conservator of Forests for the Presidency, a post he was still holding when Cleghorn came forward in Madras. **N. A. Dalzell** was under Gibson. It was not until 1861 that their joint BOMBAY FLORA appeared: two years later Gibson published his HANDBOOK TO THE FORESTS OF THE BOMBAY PRESIDENCY, and inserted into it an enumeration of the valuable forest trees of India as a whole. In the year after this he retired, giving to the Calcutta Garden, as he left, his collection of dried plants. Dalzell did not immediately succeed Gibson; but by way of economy the Bombay Government united the posts of Conservator of Forests with the charge of the Dapuri Garden in the person of **Eyre Champion de Crespigny** whose collection of dried plants is now the property of the University of Manchester. de Crespigny retired in 1862: Dalzell remained in India for a few more years in charge of the forests.

The forties had brought the first opportunity of making acquaintance with the interesting flora of Sind. Military operations led to it; they caused **Nathaniel Vicary** to be sent thither with his regiment. Vicary had been in India from before 1832, but it was not until more than ten years later that he found himself in Sind. He was a diligent collector who, perhaps because of his repeated transfers of station, let his collections suffer damage. It was probably the inconvenient size of his possessions which in 1832 or 1833 led to the gift of them to the Calcutta Garden. After that he began a new collection and when he left India for Australia there was a second gift. He published on the plants of Sind in 1854 and 1857.

The next to study the plants of Sind was J. E. Stocks.

John Ellerton Stocks (1822-1854) had been one of Lindley's pupils in London; and having qualified in Medicine he went to India in 1847 where he was sent out to vaccinate. At the end of a period of service of normal length he took his collections to Kew for determination; but he died prematurely. Hyderabad (Sind) was within his area and from Hyderabad he made his two expeditions into Baluchistan.

A contemporary surgeon of Bombay with an interest in ferns was **Andrew H. Leith.** His time of activity also spanned the year 1850. His collection is now the property of the University of Manchester. Another contemporary surgeon was H. J. Giraud. The Bombay Government brought him out from Britain to teach in the Grant Medical College and he was not of the Service which in general provided the Company's botanists. **Herbert John Giraud** (1817-1888) arrived in 1841 or 1842 with the title of Professor of Chemistry. Not at first, but after 1845 his teaching extended to Botany, and during his years he held various civic positions in addition to his teaching and is said to have been a popular lecturer. He returned to Britain in 1867.

John Forbes Watson (1827-1892) arrived in India in 1850 and taught Physiology in the Grant Medical College, then returned to Britain in 1858 to take the place that Royle had had in the service of India House as Reporter on Economic Products and Keeper of the Museum at India House. This post he held until 1879. The brothers **George Christopher Molesworth Birdwood** (1832-1917, knighted in 1877) and **Herbert Mills Birdwood** (1837-1907) arrived in India respectively in the years 1854 and 1858. The elder did much for Bombay. He had been born in the Presidency. He qualified in medicine at Edinburgh with Hutton Balfour as his teacher in Botany and was one of the keen men who helped in getting class-material together. After reaching Bombay he taught various subjects in the Grant Medical College; and a great interest in Materia Medica induced him to pay a collector on the coasts near Aden to seek for the trees yielding myrrh and frankincense. It led also, though less directly, to a catalogue of the economic products of Bombay. He served the city in many ways; among them he was Secretary of the Agri-Horticultural Society; and he took the leading part in raising money for a museum in the Victoria Park. When in 1868 ill-health drove him out of India, he carried his interests to Britain and gave his service to India through the India Office. The younger became a judge who wrote in his leisure a FLORA OF MATHERAN AND MAHABLESHWAR and an account of Indian timbers.

It may be mentioned here that the French botanist, **Charles Gaudichaud-Beaupré,** serving under Freycinet paid brief visits to Pondicherry and Calcutta in 1837; and that in 1845 the Danish exploring ship *Galathea* touched at Tranquebar, Pondicherry, Madras, and Calcutta on her way to the Andaman and Nicobar Islands, **Dietrich Ferdinand Didrichsen** collecting.

In 1850 Sir **Joseph Hooker** and **Thomas Thomson** were collecting plants with great thoroughness in the Khasia Hills. They had collected separately in the Sikkim Himalayas and the remotest parts of Kashmir; and were working for a joint account of the flowering plants of India. They would have called their publication '*Flora indica*', taking into it as much as they could, making it an account of the largest area that their knowledge could justify, just as Roxburgh had done with his FLORA INDICA and as Griffith would have done had he got so far as writing. '*Flora indica*' did not mean 'the Flora' but 'a Flora'. From the Khasia Hills they moved southwards as signs of autumn came over the uplands and, collecting through Sylhet, Chittagong, and the Sunderbans, reached Calcutta to leave for Britain early in February 1851.

Falconer was now in his second spell of work in India (1847-1855). He had been to Moulmein to report on the teak forests and was occupied, when Hooker left, in replanting the Calcutta Garden in the wake of McClelland's destructiveness. As for **McClelland,** after a short time in Birbhum he had been sent to Pegu to collect through the teak forests. Falconer had been of great service to Hooker by receiving his collections and preparing them for sending forward to London. He sent collectors of his own to the Khasia Hills to supplement Hooker's collections. **Francis Jenkins** was still the Governor-General's Agent in Assam and stimulating collecting from Gauhati. His subordinate **J. W. Masters** collected up the Brahmaputra to Sadiya. **Vicary** was making his last collections in India; he had collected in several parts of the lower Ganges valley and Hazaribagh. The strength of the army in the upper parts of the Ganges valley was so great that there was nearly continuous study of its flora. Lady **(Elizabeth) Gomme** wife of the Commander-in-Chief collected a little (1856). **William Jameson** (1815-1882) was in charge of the Garden at Saharanpur. He had been sent to Saharanpur in 1842 and when he understood that Hooker and Thomas Thomson would write a flora, he supplied them with plants in the hope of helping them . . . **M. P. Edgeworth**, now in Banda, was helpful from thence; and in the year 1850 he was transferred to Multan where he made a list of the flora. Lieutenant **William Hawtayne Parish** sent Himalayan plants from Kulu and Mandi. Brigadier **J. B. Hearsey** was sending to Kew plants from the Punjab. **Thomas Lobb** was at the time collecting plants worth culture for the firm of Veitch of Exeter; but of course a bird of passage as to India. The following three botanists reached India during the fifties—**John Lindsay Stewart** (1853), **Charles Murchison** (1853), and **James Edward Tierney Aitchison** (1858). The work of the first and the last will be indicated later; that of Murchison was little; during his two years in the Bengal Medical Service he made small collections of dried plants which he gave to Kew.

A missionary, **Francis Mason** (1799-1874), as avid of acquiring knowledge as William Carey, had arrived at Tavoy in Tenasserim and had moved to Moulmein in 1850 where he embarked on a book, small in its first edition, on Burmese plants etc., entitled NATURAL PRODUCTIONS OF BURMAH OR NOTES ON THE FAUNA, FLORA, ETC. OF THE TENASSERIM PROVINCES AND THE BURMESE EMPIRE. There was a second edition from the author in 1860 and remotely (1882) a greatly enlarged edition by another hand (W. Theobald's edition).

At the beginning of our period (1852) **Charles Samuel Pollock Parish** (1822-1897) went to Moulmein as Chaplain and threw himself with energy into a search for interesting plants. One expedition took him to the Andaman Islands.

BOTANIC GARDENS—THE BOTANIST'S FIRST CARAVANSERAIS

After the men, their memorials! And as an opening question, by what is a botanic garden to be distinguished?

A garden becomes a botanic garden when its purpose is the bringing of plants into some kind of philosophic study. It must be a garden first. The missionaries of Tranquebar doubtless were provided with a garden of vegetables as a supplement to which, from 1768 when **Johann Gerhard Koenig** came among them, they accepted what interested him in his quest for knowledge and associated it with the vegetables, as that was convenient. Then their garden became a Botanic Garden, as they indeed called it. Equally the garden of the magistrate **M. R. Smith,** at Sylhet, when he began to use it as an entrepôt between the Khasia Hills and Roxburgh in the Calcutta Garden, became a Botanic Garden; and so he and his friends named it. But the Calcutta Botanic Garden did not get the adjective 'botanic' into its name in the same way. Kyd in the letter that carried his proposals to the Government of Bengal expressly excluded from its operations the study of plants, i.e. the addition to the garden of the operation that entitled Koenig's and M. R. Smith's to be called botanic.

I have reached the conclusion that when Colonel **Kyd** set out to address the Government of Bengal on his proposal for the establishment of a Calcutta Botanic Garden, he had no clear mind as to the name to give it. He described what he was asking for in terms indicating a horticultural nursery. We have such nurseries today and there were such in Britain in Kyd's time: for instance, the first nursery held by the Veitch family was for raising trees for planting in Devon. Kyd would have the like close to Calcutta. He wanted something that was more than just a garden; as something better than a garden he called it a botanic garden. He proposed no pure botany for it and in fact explicitly wrote that there would be none.

He pointed to 310 acres along the river just below Calcutta and he estimated 200 rupees a month as the cost of maintaining. The Government approved, and began operations without waiting for sanction to come from the Directors in London. They used Kyd's name—Botanic Garden, and Botanic Garden it was to the man in the street. His expectation determined that it should develop in that direction, and so it did. Kyd lived on adjoining land and accepted charge. When the approval of the Directors came there was a comment with it that they would not have objected to a higher estimate of cost; Kyd lived for a further 9 years and, when he died, the Government called **Roxburgh** from Samalcottah to take his place. We see from the time of Roxburgh's arrival pure botany in place in the Garden mixed into the increasing stock of the nursery. The conduct of affairs now under Roxburgh diverged so much from the proposals of Kyd's first letter as to suggest that the adjective 'botanical' in Kyd's name had driven botany into the administration, actually during Kyd's years of control, so that at the date of Kyd's death it was a natural thing to call in a botanist.

Who was the founder of the Garden? Kyd for horticulture, Roxburgh in great measure for Botany.

To Banks and those in London who were taking part in the advancement of Botany through Kew, Roxburgh's greatest contribution to the Science was through his descriptions and drawings and it was customary for Banks to see the drawings.

Calcutta was in a great wave of prosperity and with consequent liberal impulses the Government was prepared to retain all the 310 acres as garden, but later took some away. Little is the information preserved on the Garden's early appearance. Its area was from a ditch bordering the property towards Howrah, on which Kyd lived, to the Great Banyan tree at the west end. This tree was young enough not to have completely suffocated the Indian date-palm tree on which its seed had germinated as an epiphyte. In depth the Garden extended from the river bank to an untidy undefined area to which Hooker thought the noisy picnickers from the city, amusing themselves by folk-dancing, might profitably be confined; and it is doubtful if at Hooker's visit the scenic possibilities of the river-front were attractively developed. But when Maria Graham visited the Garden as Roxburgh had it in 1810, she commented on its orderliness. Orderliness need not imply finish, and the scattered tanks and nurseries, remarked on by Griffith, indicate irregular and improvised extending of cultivation. Landscape gardening was not aimed at; and most certainly the Garden passed through a period when its greatest beauty was not in it but in the youth of its trees—natural, therefore, and not by art.

The founding of a garden in Calcutta led to a wish for other gardens, the promoters seeing possibilities much as Kyd saw them, but not as Roxburgh did.

Tipu Sultan of Mysore had converted a fruit-garden that his father had made in Bangalore into a garden of ease. On his downfall in 1800 the fate of this garden had to be decided and, pending a decision, it was put into the charge of **Benjamin Heyne,** he being the Madras botanist at the time, and a proposal having been made that it should become 'a botanic garden'. After Heyne it was entrusted to an agri-horticultural society; then relinquished but remaining an open space. **Cleghorn** contrived to get the status of garden restored. He made his recommendation in 1856; and it was to apply to 50 acres. A horticulturist named **New,** to whom there is a *Strobilanthes* dedicated, was put in charge; then followed **Allan Black,** sent out from Kew in 1863, but he lived for two years only. Black (1832-1865) had had a horticultural training at Kew and had held the post of Curator of the Herbarium. After him the Bangalore Garden had for its Superintendent from 1873 to 1907 **John Cameron,** to whose planting it has owed much of its beauty.

Another Cameron—**William Cameron**—had left Kew about 16 years earlier for the similar service of horticulturist at Peradeniya. It is said that when in 1857 he went to Ceylon he was entrusted with the conveying of a consignment of cinchona plants. He left Government service in 1860 for coffee planting, was hit by the coffee-leaf disease, and piloted his estate back using cinchona.

One year before the death of Tipu, Ceylon had obtained a small acclimatization garden in Colombo entrusted to a gardener named Jonville, brought from Europe by a new Governor. This garden, to give it a better position, was removed for a short distance in 1810; then to increase the field of interest Banks caused **William Kerr,** a Kew gardener, to be sent out in 1812. Kerr had travelled to collect desirable plants and could be relied on to bring together such as he could get and grow. The Colombo site however was still condemned, as it was liable to be flooded; but there was available an abandoned sugar plantation at Kalutara, which though 26 miles from Colombo, was accepted; and the garden was moved. Kerr died in 1814, and another who had had the same training in travelling and collecting, **Alexander Moon,** was sent to Ceylon to replace him (1817). In that year the Government completed its military road from Colombo to Kandy. It was decided on this that Kandy should be the hot weather station of the Government with a residence for the Governor, and, following that, to use Nuwara Eliya as a sanatorium, for which purpose the road was continued right to the very middle of the hills. It opened a wide area for planting, and there was a rush into it of would-be planters, many of them very ignorant of planting possibilities. To meet the situation, the Government set aside about 150 acres at four miles from Kandy for a garden that could illustrate possibilities as well as acclimatise and become a Botanic Garden. They closed Kalutara and sent Moon uphill after the planters.

The Dutch when they held the coasts of Ceylon had tried to introduce coffee-growing as an industry. They got no further than to familiarise the bush in the coastal villages. The excellence of the hill climate for growing it did not remain unkown; but the cultivation in the hills came only with the entry of planters from 1817 forward. One of Moon's first acts when in possession of Peradeniya was to lay out with coffee an area conspicuously where the new high road passed the Garden and to lay out another with the traditional crop, cinnamon. These, the reader realises, were demonstrations. Moon added as he could, in order to attract the interest of the passers-by, a few acres near the gate of miscellaneous cultivation; the balance behind remained in natural forest.

This founding was in many ways unlike that of the Calcutta Garden; it was a lone job for Moon, whereas the founders of the Calcutta Garden had abundant well-wishers and potential supporters.

The two were alike in the liberal provision of land. Moon had the London idea of what a Botanic Garden should be; he backed it up by determining his plants, catalogued them and found an artist who pictured them. What he got into the cultivated acres can be gathered from his CATALOGUE OF CEYLON PLANTS, published in 1824. He died in the next year, a great loss. There is evidence that **Jonville** collected and dried plants.

Two years passed before Moon's successor arrived. This was **James Macrea** whose training for his work had equally been by travelling as a collector of useful and ornamental plants. Macrea died in 1830 and again it took two years to secure a successor. He was **James George Watson,** accepted on Wallich's recommendation, but not a success in the post. General Warren Walker's scathing condemnation of him has been quoted. At the time of Watson's death in 1838, the Government was allowing the produce of the Garden to be sold in Kandy; and it found locally successive caretakers, (i) in **J. G. Lear,** a professional horticultural collector who had been sent to Ceylon and (ii) and (iii) in two of the island's surgeons, **H. T. Normansell** and **W. C. Ondaatje.** They were naturalists and no doubt did faithful curating. Normansell died. A little later we discover Ondaatje on a visit to London where he joined the Linnaean Society. Exhibits which he brought to meetings indicate that he had an interest in medicinal plants. But in 1844, at last the post of superintendent was filled, as General Walker urged, by one able to study the botany of the island. This was **George Gardner,** with a qualification in Medicine, a pupil of Sir William Hooker and with a reputation as a botanist got from extensive plant-collecting in Brazil. At Peradeniya a close friendship sprang up between Gardner and Sir **Emerson Tennent,** who was at the time Colonial Secretary, so close that the botany in Tennent's CEYLON must have been talked over by the two in their rambles together. Tennent praises the Garden for horticultural efficiency. There were flower borders but not yet any of the art of landscape gardening.

Gardner died in 1849, and the custom established, of employing a botanist, led to the appointment of **Thwaites.** When Gardner was put in charge, 40 acres out of its 140 were in cultivation and, taking into consideration the way in which the Garden had been officered, it is hard to see how the planting community had had a real lead.

In 1821 the Governor-General of India, Lord Hastings, visited the North West Province[1]. The reconstructed canal carrying water to Delhi was one of his interests and he visited Saharanpur near to its head. In that pleasant station his attention was drawn to a neglected fruit-garden supported originally by the revenue of seven villages on the foundation of a public-spirited administrator and dedicated to the improvement of local horticulture. In its neglected state, self-sown inferior mango trees standing in coarse grass filled it. Lord Hastings decided that it should be preserved and replanted under the care of the Civil Surgeon, who at the time was the fully competent **George Govan.** Under him its small area of only a few acres was extended; canal water was brought in; roading was done; lawns made and it was dedicated anew to its original purposes. Govan, to extend its work, opened a nursery at Nahan on one of the routes of trade from the plains into the Himalayas. Retiring in 1823, he was succeeded by the energetic **J. F. Royle,** who intensified the work and investigated the flora on the near-by hills by sending collectors for plants and seeds, creating a herbarium, employing agents to bring fruit trees from Kashmir and, when Wallich went on leave, obtaining the services of the Calcutta artists. He closed the Nahan nursery, when he was able to open a larger and more elevated one at Mussoorie. Saharanpur with Mussoorie in support had resembled Kalutara with Peradeniya in support, if Kalutara had been retained; the years were the same.

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[1] Later the united Provinces of Agra and Oudh, and now Uttar Pradesh.

Royle gave to Saharanpur all required to make it a Botanic Garden, of the Kew type, the display, the botanical nomenclature, the study of plants, and a recording in print and by illustration. Assuredly he knew Kew. The distance of Saharanpur from Calcutta and the entirely dissimilar climates kept the two Gardens from any competition. But in the eyes of the Administrators, the elder was always the elder brother, staffed therefore by the experienced, for instance Hugh Falconer, Thomas Thomson, and Sir George King; each in his time was entrusted with the care of Saharanpur before promotion to the care of the Calcutta Garden.

The north of India under Persian influence obtained a number of gardens of ease. Tipu's at Bangalore was the Persian influence carried to the south of India. All that Tipu's garden did towards the promotion of Botany was to provide land used botanically after a long interval. The Saharanpur Garden was not of the same kind of origin; but again what it did was to provide land after a break just as Tipu's garden did.

Three of the north-western gardens of ease may be mentioned in passing: (i) that at Fatehpur Sikri because it is so instructive in construction; (ii) that at Shalimar, a little to the west of Lahore, because though never serving in pure Botany it played a part in fruit selection, and (iii) the better known Shalimar Garden in Kashmir for we have descriptions of it as it was. This garden, set on a superb site, exposed too much art.

I have need to revert to the Calcutta Garden. In the year 1830, Wallich being on leave in Britain, a Retrenchment Committee cut the financial support for the Garden so severely as to arrest progress. Wallich on his return to Calcutta in 1832 found he had to retrench; he could not withdraw from raising large quantities of stock for giving away and also for supplying to small experimental patches up and down Bengal which were in his charge. He did not send out collecting parties and, as I have said elsewhere, showed an unwillingness to maintain a collection of dried plants. His accumulation of drawings suggests economy, for a record exists to the effect that during his second period of service his artists gave him 552 drawings against the 2350 done for Roxburgh. I take it fair to say that this retrenchment fell on the development towards a mature Botanic Garden; and that the ideas of the Government retrogressed towards Kyd's nursery establishment.

Griffith, who criticised Wallich for abandoning Botany, took a very curious and unjust position when, along with the attribution to Wallich of what he saw amiss, he promised the Government in asking sanction for undoing so much of Wallich's work that he would do it on his budget allowance; for this he implied that the allotment was adequate. Of course the Government wished it to be so, and went on wishing until the Crown displaced the Company.

GARDENS ADDED FROM 1830

The first of these gardens was that of Bombay; it was originated by an agri-horticultural Society in 1830. Two years earlier **John Graham** had reached Bombay; and he was involved in the Society's welfare from its foundation. He had reached Bombay without employment, but must have had reasons to expect it. It seems that he was known in advance to the Governor, Sir John Malcolm, and the Governor took him into his own household on arrival. The Society formed an acclimatization garden at the suburb of Sewree and Graham could examine Bombay plants cultivated in it.

When Graham had ready for the press his CATALOGUE OF PLANTS GROWING IN BOMBAY AND ITS VICINITY, the Society undertook to see it printed. As we discover two grants of money from the Government to the Society, one just before printing and one after, the inference that the Government was helping to finance its publication seems correct, although the Society had another cause for needing money, namely their expenditure on the laying out of their grounds by an expert named **MacCulloch.** Graham died when the type-setting had reached its 200th page.

The Society had willing support from some of the best of the citizens of Bombay. These may be named: **George Buisk** the Editor of *The Bombay Times,* **H. J. Giraud** who was called to Bombay to teach in the Grant Medical College and served the city in various capacities, and Dr. George Birdwood who also taught.

George Christopher Molesworth Birdwood (1832-1917, knighted in 1877) was born in India, then graduated in Medicine in Edinburgh and returned to India in 1854. In Edinburgh he had been a pupil of John Hutton Balfour a great teacher. When he had returned to Bombay, it fell to him to teach Materia Medica in the College. Out of his great energy, the Victoria Museum came into existence in the Agri-Horticultural Society's park. In 1862 he catalogued the economic products of Bombay; and he returned to Britain in 1868 on account of illness, but to continue economic work at the India Office.

The city of Madras obtained a botanic garden in the same way as the city of Bombay, namely through an agri-horticultural Society, the date being 1838. The reader notes that it was within eight years of the Bombay garden, and it is to be added that the Society grew on the willing service of the citizens in a like measure. It has been recorded that **Wight** in 1838 was taken from military service and instructed to look into the state of Agriculture in southern India. The year was that of the foundation of the Society's garden and Wight who had been called to Madras city looked after it. The records call him Superintendent. **H. C. F. Cleghorn** similarly looked after the garden when he was a professor in the Medical College (1852 forward). An Army officer, **Francis Alexander Reid** was Superintendent for a while. The Society for a considerable period had the services of the horticulturist, **Andrew T. Jaffray.** Another horticulturist, **Robert N. Browne,** trained in Edinburgh, succeeded from 1857 to 1863, and wrote a guide book which went to a second edition, edited by the surgeon, **John Joseph Wood** (1828-1867). He at the time was on the staff of the Medical College. When Wood left India the Garden was again superintended by one of the fighting forces, an officer of the Army, **Robson Benson** (1822-1894, ultimately a general) who had done the same service for the Agri-Horticultural

Society in Rangoon at the time (1865-1869) when he was with his regiment in Lower Burma.

Sir Joseph Hooker spent a day ashore in Madras at the very beginning of 1848 and passed his time in the Garden. Catalogues of other dates than those named above were issued. Certainly the Garden was very active.

A catalogue of the plants grown, prepared by **James Matthew Gleeson**, Superintendent of the garden, who left Kew for India in 1870, in the first instance to superintend experimental cotton cultivation in 1899, runs to 95 pages. It was issued in 1884.

The Nilgiri Hills, as we have seen, were coming forward and Ootacamund becoming a sanatorium in the days of Schmid, Metz, von Hugel, and Baikie. This development led to the establishment of a Garden of ease. A resourceful gardener from Kew laid it out in 1848. This was **William Graham MacIvor.** He had more land than he could immediately use, but it was not long before it was required for the experimental raising of Cinchona, whereby the garden may be said to have become a Botanic Garden. MacIvor died at his post in 1876.

To accommodate cinchona in Ceylon on its arrival the high level plantation of Hakgala was laid out as a branch from Peradeniya. The second horticulturist to be in charge of it, **William Nock,** whose service in Ceylon lasted from 1881 to 1904, was sent to Hakgala in 1882, and he embellished the area by extending the range of the plants cultivated. What he found the garden would grow may be read in a contribution which he made to Lemesurier's MANUAL OF THE NUWARA ELIYA DISTRICT. For the sanatoria of the Himalayas to get gardens may be regarded as natural; for a garden is a part of the road to health. The Garden at Naini Tal and the Lloyd Botanic Garden in Darjeeling were created on land donated for the purpose.

After the fighting in Lucknow in 1857, those who sought to remove the disfigurements set aside an area for a garden. At first it was but a garden of ease, indistinguishable in purpose from a half-dozen other gardens in the northern plains of India, but the second officer to be in charge of it, the surgeon **Emmanuel Bonavia,** added experimental studies of fruit trees (1876) and from that time it has had a claim to the name of Botanic Garden.

Emmanuel Bonavia (1826-1908) had entered the Bengal Medical Service in 1857 and was in charge of the Garden at Lucknow in 1876. It was then that he began to write about citrus fruits, their classification, and their history in cultivation, and about the date palms and other botanical subjects.

HORTICULTURE IN ALLIANCE

Horticulture is one of Botany's technologies. At any rate the two are mutually helpful; and botanists have been not a little indebted to the horticulturists for bringing the plant world under their eyes. The whole of the credit of conveying tropical plants alive and keeping them alive in temperate lands belongs to the horticulturists, for they worked out ways of transporting over the sea between India and the lands where Botany had a stronghold and they devised plant-houses with an artificial climate for their reception. There had been a century of experimentation from the time when the first plant-house was built for Clusius to the time when Europe had stoves hot enough to encourage a flow of plants from India to the curious in horticulture in western Europe. This section of my paper is devoted to the gains of Botany by reason of the aspirations of horticulturists, and the Calcutta Garden was called in to aid, if not already in Kyd's time, at least as soon as Roxburgh had been called to Calcutta. In the year after that (i.e. in 1794) the Company appointed **Christopher Smith** their 'Botanist at Calcutta'. His business was the stocking of the Company's possessions in the East with economic plants and he caused thousands of plants to be transported by sea within the tropics. The transport to Europe, which of course was round the Cape, was a somewhat more exacting task.

At that time a very generous friend of the Calcutta Garden was **M. R. Smith,** the magistrate stationed at Sylhet. His position enabled him to tap the riches of the Khasia Hills; and I would attribute to him the beginning of horticultural exploitation. At the same time **Francis Pierard** was sending to the Garden plants from the direction of Chittagong. **Francis Buchanan** had been to Ava with the Symes Mission and later was able to visit Chittagong where a flora of Burmese type is met with; and he too enriched the Garden. **Roxburgh** is known to have contrived to get orchids in good state to London where they were established in stove cultivation and to flowering (1813). **Wallich,** with the way shown to him, posted a collector at Pundua to work from a boat where M. R. Smith had gardened up to his death in 1819. Duty had sent Wallich to Lower Burma and to Northern Tenasserim, where he personally touched a flora rich in beautiful plants and after his return he had a collector there. He sent plants into cultivation freely.

Let the reader suggest, if he can, why so many beautiful flowers seem to have had their evolution there.

In 1818 the Royal Horticultural Society of Britain, being 14 years old and having created for itself a garden with greenhouses, set to work to furnish these by sending gardeners to various destinations to seek and bring back desirable, chiefly ornamental, plants. One of the gardeners was **John Potts,** who went by ship of the East India Company to Calcutta and to Canton. From Calcutta in spite of being based on the Botanic Garden his success seems to have been small—Wallich would be in Nepal at the time. But it was otherwise from Canton where **John Reeves** was living; and Reeves put him into the way of getting the showy plants of the Chinese flower market. Doubtless Potts travelled back along with what he had obtained in Canton and cared for it (1821), but was compelled to entrust to others his earlier consignment from Bengal. The lesser success from Bengal may not have been by his fault; but most certainly the Chinese had gone further than Bengal in flower selecting.

Many botanists must have asked exactly where Pundua is: it was 16 miles north-west of Sylhet, and owed its importance to shallowing water arresting trade and making it a terminus on the river; and it would be an excellent base for collecting. As Wallich's collecting trips would be somewhat expensive, the cessation of such after the Retrenchment Committee's sittings in 1830 is understandable; but a trip such as de Sylva's would have brought much living material into the Garden.

When Wallich went on leave in 1828, he took living plants with him as well as his accumulation of dried plants. Five years after Wallich's return the then Duke of Devonshire, who had adopted orchid-growing with enthusiasm, sent a gardener by name **John Gibson** to collect in the Khasia Hills. Gibson, aided by Wallich's direction and support, brought back large and possibly rather indiscriminate supplies but a number of novelties to cultivation (1837). Only a little more than a year earlier Wallich and Griffith had crossed the Hills seeking the tea bush; and **Griffith** was at the time of Gibson's visit at the head of the Brahmaputra valley. He had not seen *Vanda caerulea*, the gem of the Hills on that, his first crossing (1835), but did so when he varied his route in 1837. But Griffith did not take it alive; he dried specimens of it.

John Gibson (1815-1875), after some years at Chatsworth, moved to London, and in a busy life laid out or controlled nearly all of the large parks in London.

It is very evident, and indeed natural, that greenhouse plants sold in Britain more readily than stove plants; and therefore China was the country to search but, if stoves were to be favoured, then the Khasia Hills were to be visited. The firm of **Loddiges and Sons** employed a collector in India; but it is not recorded who he was nor whither he went. It was to the Khasia Hills that the Duke of Devonshire sent his collector John Gibson.

Gibson's cases of living plants would need to be carried round the Cape and therefore be long at sea, and though the Wardian Case had been invented (1836) it is not certain that he was able to use it.

In 1843 the firm of **James Veitch and Sons** of Exeter sent their employee **Thomas Lobb** to Singapore as a collector. At Singapore he was to determine if the disturbed state of China would allow him to work there; if it would not, he was to go to Java: he went to Java and some other parts of Malaysia. In 1848 he signed on for another expedition and sailed for Calcutta. Among the many places he now visited were the Khasia Hills. Later he went to Tenasserim and he continued his travelling life over many years. He was away in 1853 when his employers moved that part of their business which was with stove plants to London, splitting the firm; and Lobb's services were thenceforward concentrated on the London half which became the predominant half. Hooker's record of Lobb's 'circus' passing him in the Khasia Hills has been recalled.

Contemporaneously **Simons,** the Government's apothecary at Gauhati, was sending local plants into cultivation and so also was a collector named **Freeman,** and a Captain **Williamson** who sent orchids to his uncle **John Day** (1821-1888), whose enthusiasm as a cultivator led him to make a trip to India, both to the north-east and the south, to inform himself on their cultural requirements.

In the fifties the lure of the orchid began to move south-eastwards. **Charles Samuel Pollock Parish** had become chaplain at Moulmein (1852) and he probably brought more eastern orchids into cultivation than anyone else, keeping the stream up at least until 1871. While Parish was active from Moulmein, so equally was an officer of the army, **Robson Benson,** ultimately a General (1822-1894), in Rangoon where he looked after the Garden of the local agri-horticultural Society. His most generous area was a transect of the country from the Arakan Yoma at the Toungup pass through Prome and through Toungu to the Shan plateau; the transect connects the best teak forests of Burma with orchids, but he obtained plants from other parts of Burma.

Following General Benson came Major-General **Emeric S. Berkeley** who sent orchids into cultivation from various parts of India but chiefly from Burma. Of the professional plant collectors, Thomas Lobb's activities were along the trail made by M. R. Smith, Wallich, Gibson, and Simons and secondly in Tenasserim followed one of Wallich's trails which Parish had reopened. After these came **William Boxall,** first penetrating the area of the Lower Burma teak forests whence Robson Benson had drawn many orchids, then going into the Shan States because the exploring of Sir Henry Collett had exposed some of its riches.

There is a great interest but little explored in delimiting the area of the evolution of the magnificent orchids. The evolution has required long ages of continual tropical humidity fixing the plant and fixing its pollinating agents. Both are involved. **Henry James Murton** (1855-1881), the first horticulturist to be put in charge of the Singapore Botanic Garden, was seeking in the year after he had left Singapore to start in business as an orchid collector; his area Siam. Another collector of the same time was **J. C. Prazer,** who took employment under Sir George King when it would seem he was in Manipur. Thence he moved to the lower valley of the Salween.

THE LARGER MUSEUMS IN INDIA AND THEIR GROWTH IN EDUCATIONAL VALUE

Long ago, about the year 280 B.C., a Greek in power in ancient Egypt set apart a building, called the Museion, for the promotion of learning—whence the word museum. This building seems to have had attached to it land for the cultivation of plants and for the exhibition of captive animals. It is nice to recollect how long the word 'museum' has indicated a building where one stores to study and displays to instruct; and then the historian enquires into the line of culture intended by the dedication.

I propose to bring into one view the dates when India dedicated in its turn buildings as museums and the different sciences which benefited. The dates are somewhat clustered in the fifties of the last century.

1817: the Asiatic Society in Calcutta, at that date 30 years old and the possessor of a house holding their library and objects, mainly archaeological, which had been donated to the Society, planned to display these objects, and make the building function as an Archaeological Museum (let us call this collection No. 1), and further they would have it extended to Zoology (2), Geology (3), and Botany (4). But Botany soon fell out of the planning.

1819: it seems that Madras put by a little museum material (see Markham & Hargreaves, THE MUSEUMS OF INDIA: 176; 1936).

1840: the Government, directly interested and very desirous of increasing the public interest in India's mineral wealth, planned a 'Museum of Economic Geology' within 3, and

1841: brought into India from Britain a large collection of minerals (5) which was placed beside item 3.

1841: the Government at the same time agreed to give sufficient financial aid to pay a salaried whole-time Curator, and **Edward Blyth** was brought from Britain. Under him the zoological material (2) grew into a large collection.

1846: we read of a collection being formed in Madras (7) perhaps based on that of 1819; and we read later of a collection which would seem to have been the same or a part of it, being in the entrance hall of the Madras Medical School.

1850: the Government of India created the Geological Survey; and the Survey began to make a collection (8) in its own possession. In 1856 it was able to withdraw 5 from its position alongside 3 to its own premises.

1853: the Government of Madras planned an Exhibition and started energetic collecting for it (9), and absorbed 7. The London 1851 Exhibition doubtless suggested the Madras exhibition of 1855 to its promoters. When the Madras Exhibition came to closing, the Government desired to retain a part and having a building available converted that building into the Madras Museum (1857).

1855: the founding of a museum in Bombay had been under discussion for a few years; in 1855 a museum (10) of Economic Products of Bombay and processes of their manufacture took origin and was opened in 1857, then disordered by a hasty removal. Sir George Birdwood's CATALOGUE OF THE ECONOMIC PRODUCTS OF BOMBAY (1862) suggests what material was in it—at least in its earlier years. It became a mixed local museum, after reorganization.

1856: though the removal of the economic minerals (5) from the Asiatic Society's building gave a little relief, the museum remained overcrowded and the zoological collections (6) in particular were in need of much more room, moreover the geographic range covered had widened. Then the Asiatic Society memorialized the Government of India for the establishment in Calcutta of an Imperial Museum, and expressed their readiness to transfer all their extensive collections, except their library.

1866: the Indian Museum Act was passed, whereon collections 1 and 6 became possessions of Trustees created under the Act, while 3 was transferred to the Geological Survey.

1872: the Lieutenant-Governor of Bengal, Sir **George Campbell,** moved to get the economic products of his Presidency collected. A committee was set up in every district which collected samples of the grains, seeds, oils, fibres, timbers, and minerals. This collection (11) doubtless was very comprehensive by 1879 and had a considerable value; but the cart was before the horse, as the essential building—the Museum proper—to hold the collection was wanting. Disorganization then set in with vagabondage.

1875: the new Imperial Indian Museum building was ready for occupation by 1 and 6.

1882: an enquiry was raised if the Museum building could be made to hold an economic line; to this the reply was 'not without enlargement'. This was followed by a request for the temporary use of a part of the building to assist the holding of an exhibition; and an agreement was made that in return for temporary use an economic wing should be added.

1883-1884: the Calcutta Exhibition. By most energetic collecting exhibits (12) were brought together into which 11 had been absorbed.

1891: the wing of the Indian Museum for the display of Bengal economic products having been completed, stocking it began; but a considerable amount of replacement had become necessary, and this collecting (12) was set about. It required time. That which was good in the material was used for the Exhibition, and the new collections were gradually brought together, and the gallery receiving them was opened to the public at the commencement of 1901.

Until then Botany had had no place in the Museum; and, as my reader understands, it was only economic botany that now obtained a place.

Museums are of many kinds; the best have grown with declared purposes; some have been or have become no more than depositories.

After the founding of the Madras Museum several small museums were set up by decree in the Presidency. One is said not to have functioned; the others did in a way, but it is evident that they were too small to maintain interest, though even the smallest may have done good by intercepting historic stones and the like which were exposed to loss; in this doing as the beginnings of the Asiatic Society's collection did.

There is a particular interest to be found in the earliest years of that collection.

To the year 1817 the Society's house would have been a depository, though the establishment of a museum must have been adumbrated. The first official suggestion came in that year from Wallich, who had been 7 years in the East, had practised medicine in Serampur, and now was residing in Calcutta seeking a new medical practice and had not yet so succeeded as to be without leisure. He offered his services. The Council took up the idea, discussed the scope, and accepting Wallich's offer drew up a list of classes of gifts that they would receive, at the same time naming Wallich 'Superintendent of their Oriental Museum'. Difficulties for him were only just round the corner. He was almost immediately accepted as an Assistant Surgeon in the Medical Service, and ordered to join the column marching on Kathmandu. Where now was his availability? Though he did not join the forces he did not become fully available for the museum, as he was sent to the Calcutta Botanic Garden to take Roxburgh's place and the Garden needed the whole of his time. Wallich, however, kept the title of Superintendent.

The archaeological exhibits as they came in went into the care of the Librarian; it would be a simple matter for Wallich to separate the geological and zoological and to take the botanical to the Botanical Garden; but one does not know if there were many of the last. The Society on second thoughts had decided that botanical objects belonged to the Garden. After a few years so much travelling fell to Wallich that he could have had nothing to do with this receiving and putting away and a clerk looked after it; visitors were asked to help if they could.

The list of desiderata prepared by the Council when asking for specimens shows that the Society thought to educate their own members, not the public. The next move was an attempt to educate whoever it could reach in geological products, by the side of the most praiseworthy steadfastness of the Society in taxonomic zoology. Botany was kept apart, one may say, by the difference due to the way of handling its specimens.

Before Wallich's day, Roxburgh from the Calcutta Botanic Garden had collected and dried plants. He valued them less as evidence than he did his artists' drawings; he had no museum building and he dispersed the specimens to those who had the means of storing them. Wallich at 1828 likewise dispersed all that he had at that date. He too had no museum building, but kept part of the specimens in the basement of his own house and another part in a seedhouse for the convenience of his more advanced horticultural staff.

The missionaries in Madras made an effort at continuous use of dried plants for identification, and Rottler showed himself so convinced that the Calcutta Botanic Garden should do as they did that he forced on Wallich the recommencement of maintaining a collection. Seeing him as he was on his way back to Calcutta in 1832, he gave him a bundle of dried plants.

Wallich took the lesson and proceeded to rebuild the set for the garden shed. **Vicary** seems to have followed by unloading his baggage on to Wallich; and Wallich in this way seems to have found himself not exactly with a herbarium but with a collection of collections. I do not know which of his successors did most of the work of unification; perhaps it was **Thomas Thomson.** Under **King** the material increased very rapidly, and King was successful in persuading the Government of Bengal to supply a fire-proof building for it (1883).

Common usage, because it associates display with museums, tends to dissociate herbaria and museums.

Exhibitions are temporary museums; but that statement does not carry a complete parting line. Exhibitions do not provide for research, which is what museums do. However exhibitions display very generally material suitable for museums and become part parent in consequence.

The first exhibition staged in India, that of Madras, gave hope to those concerned with education that the illiterate, to whom a label conveyed nothing, gathered knowledge by the sight of classified objects. Certainly they do.

The organizing of the exhibition was put into the hands of Surgeon **Edward Green Balfour** (1813-1889), who had been in India from 1838 and was to be Surgeon-General of Madras before he retired. His organizing work in this connection led to the publication of two books: his CYCLOPAEDIA OF INDIA, 1857, and his TIMBER TREES OF INDIA, 1858. The Exhibition led to two other publications: Sir **Walter Elliot's** so-called FLORA ANDRICA, 1859, and Colonel **Heber Drury's** USEFUL PLANTS OF INDIA, 1858.

Walter Elliot (1803-1887, knighted in 1866) had had rather long service in the southern Maratha country, where he had studied the local fauna rather closely; in 1837 he became Private Secretary to Lord Elphinstone, the Governor of Madras. Next he was transferred to the Telugu-speaking part of the Presidency and was there at the date of the exhibition. His so-called FLORA ANDRICA is a compilation of plant names, got together by his contact with the people and through pundits; and shows that he must have known the flora. He was a man of many interests and a well-proved administrator.

Heber Drury (1810-1878) was a Colonel in the Madras army who studied with not a little care the flora of the southern parts.

The following officers were connected with the exhibition in different ways: General William Cullen, Resident in Travancore with the same interest as Colonel Drury, and the horticulturist Andrew T. Jaffray, then serving the Madras Agri-Horticultural Society. He did great service in assembling the exhibits. Later the name will be found in these pages in connection with the introduction of Cinchona.

Surgeon **Balfour** controlled the Madras Museum which, as said, was the outcome of the exhibition; and the study that he caused to be made of visitors is interesting. He kept statistics of their ability to read, and of course found a very large amount of illiteracy which frustrated in their case all values in the labels. Nevertheless it seemed that the illiterate did profit. The Government proceeded to arrange small museums for their larger towns. These must be called on the whole failures.

Few know that colonial Botanic Gardens throughout the Empire had received at one time instructions to keep small collections of plant products in the round and in a small number of cases the experiment succeeded.

The collection of miscellanea in Bombay did not come into their Museum in a manner quite like those of Madras: they were brought out of a store room in the Custom House as soon as there was a Museum building in the Victoria Park into which to put them (1857). The erection of this building has been mentioned earlier; the year was 1871.

Why Calcutta got its museum buildings later was mainly because it was a very much larger proposition to build the Indian Museum than it had been to build the Museum in Bombay. The year was 1875, twenty years after the institution of the Geological Survey of India, and 15 after the Asiatic Society in memorial to the Government of India had asked for the building, not of a Presidency Museum, but of an Imperial Museum, whereinto what they had stored could be taken. The reader notes that the date of this coincides with the creation of the Madras Museum and not unrelated to the planning of the Bombay Museum.

All three museums of the presidency cities had attained functioning when in 1882 the Government of Bengal sought to get the range of the display extended on the economic side and received the reply that this could only be by adding to the building. Then followed an enquiry if the Museum could be made the focus of an exhibition and the discussion ended in an agreement that in return for this temporary accommodation the Government of Bengal would add a wing and so it did in due time: the Economic Section. Meanwhile the Calcutta Exhibition of 1883-1884 ran its course. The Government of Bengal naturally passed over to it what there was in its 'Economic Museum' though the specimens were in a sorry state. These—grains, fibres, oil-seeds, drugs, timbers, and minerals that had been commandeered from all parts of Bengal—had very soon after the institution of the collection outgrown the space allotted to them and more than one move had thrown them into disorder, into some neglect and disrepute. The collection was advantageously broken up with the retention of no more than was worth keeping and this now made part of a new collection gathered from all parts of India. Now the native of other parts of India who visited the exhibition could see what came from beyond his own knowledge, and surely this was a gain on the showing to the native of Bengal what might be familiar to him. The new wing which the Government of Bengal had promised was ready in 1891 and the Exhibition's collection, screened afresh and added to, was arranged in it over the years 1891 to 1901. The reader can if he desires get all the details for which he is likely to wish in the volume issued by the Trustees in 1914 for the Museum's Centenary.

The Imperial Museum in Calcutta and the Presidency Museums in Madras and Bombay have been immensely popular and undoubtedly have passed forward a great deal of elemental knowledge. The Superintendent of the Madras Museum, Dr. E. G. Balfour, kept a register of the proportions of literate and illiterate among the visitors and the percentage of the latter was high enough to suggest that the least promising gained something.

It is interesting to note that the earlier geologists of the Geological Survey lent themselves to promoting the collecting of plants almost as if they thought it incumbent in them. Thomas Oldham, Valentine Ball, William Blanford, and Ferdinand Stoliczka were of the Survey and remitted dried plants to the Calcutta Garden. Still more the zoologists did this—the surgeon John Scully, the ornithologists T. C. Jerdon, Allan O. Hume, and Eugene W. Oates; the entomologist W. S. Atkinson; the malacologist Lt.-Col. Henry H. Godwin-Austen, and others who will be named later.

(*To be continued*)

A Natural Sanctuary in the Himalaya:

Nanda Devi and the Rishiganga Basin

BY

HARI DANG

The Doon School, Dehra Dun

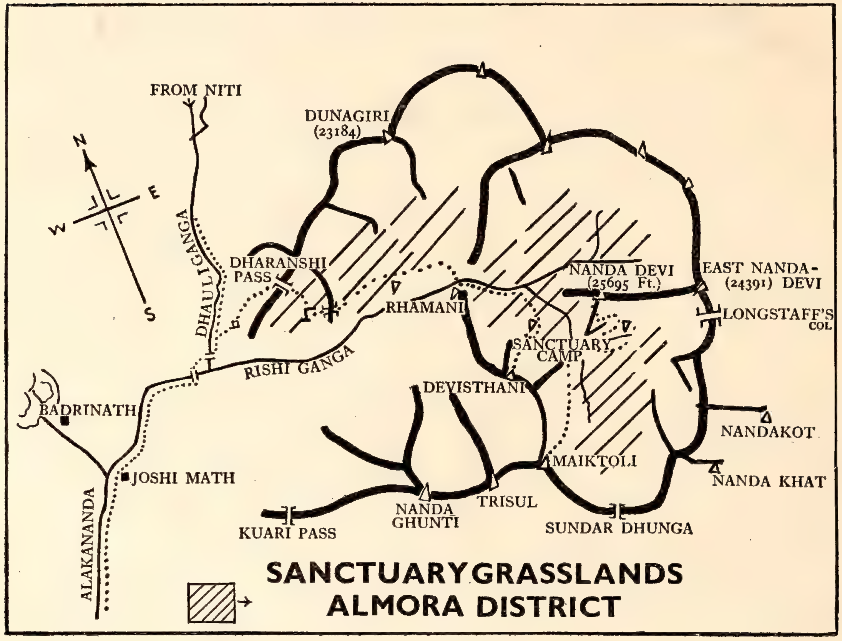
(*With a map and two plates*)

INTRODUCTION

Though I had heard of the natural sanctuary formed by a ring of high mountains around Nanda Devi in 1942, it was only in 1960, and again in 1961, that it was possible to actually visit the area, primarily with the object of mountaineering and photography. The second of these two trips eventually came to be sponsored by the Indian Mountaineering Foundation, the Mount Everest Foundation, London, and *The Statesman* newspaper, and the following report is based on information gathered during these two trips.

Nanda Devi is not only the highest mountain in the central Himalaya, but dominates 250 inaccessible square miles of the most beautiful mountain scenery in the world. The area around Nanda Devi is ringed by a continuous high ridge which descends below eighteen thousand feet only where Rishiganga River, draining the numerous glaciers of the region, has cut a deep and difficult gorge through the western side. Nineteen known summits of over 21,000 ft. stand on this ridge, which is located between the Dhauliganga and Goriganga rivers of the Kumaun-Garhwal Himalaya.

Much of this 250 square miles of mountainous terrain is alpine forest and pastureland, some accessible alps used by village flocks of sheep and goats, the greatest part the haunt of a wide variety of animals and birds characteristic of the higher Himalaya of the Indian region. The floral abundance alone is astonishing, not only putting the famed Bhyundar Valley (Frank Smythe's Valley of Flowers) into the shade in comparison, but also offering a potential hunting-ground for the plant-hunter because of its insular virginity. If detailed and expert surveys were carried out in the region, many instructive and useful relationships, ecological and biological, might emerge about environmental adaptation in the complete absence of human influences such as are not possible elsewhere in the higher Himalaya.


FROM NITI
DUNAGIRI (23184)
N
E
W
S
DHAULI GANGA
DHARANSHI PASS
RHAMANI
NANDA DEVI (25695 Ft.)
EAST NANDA-DEVI (24391)
LONGSTAFF'S COL
SANCTUARY CAMP
BADRINATH
RISHI GANGA
DEVISTHANI
NANDAKOT
MAIKTOLI
NANDA KHAT
JOSHI MATH
ALAKANANDA
TRISUL
NANDA GHUNTI
KUARI PASS
SUNDAR DHUNGA
▨→ SANCTUARY GRASSLANDS
ALMORA DISTRICT

It is the purpose of this article to consider a far-sighted plan for preserving this whole self-contained watershed as something more than a Game Sanctuary, which is its present status according to the Forest Department. This may, it will be suggested, be profitably made the first Wilderness Preserve in India, after the pattern adopted in the United States.

Historical

The Survey of India had always looked upon the gap in their knowledge of this area as more or less inevitable because of its extreme inaccessibility. Light was first thrown on it by men working under the incentive of mountain-climbing and exploration,

W. W. Graham, accompanied by two Swiss guides, Ulrich Kauffman and Emil Boss, was the first enthusiast to try to force the gorge of the Rishi where it meets the Dhauliganga, some fifteen miles above Joshimath on the route to the border pass of Niti. A lone explorer and some hardy sportsmen, who have left no records, were his only predecessors, and he failed entirely in his attempt to traverse the almost overhanging lower section of the gorge, reaching the relatively easier middle-section of the Rishi over the 13,000 ft. high Dharanshi Pass situated on the outer ridge to the north, where it descends from the 23,184-ft.-high Dunagiri Peak. Graham claimed to have climbed Changabang, an extremely difficult mountain above the foot of the toughest portion of the Rishi gorge, from where the Nanda Devi massif is only five miles away.

It was left to Dr. Longstaff in 1907 to make another attempt, and this he did with the Swiss guides, the Brocherel brothers, and General Bruce, of the Gorkhas. He also entered only the easier middle-section of the Rishi, known as the Outer Sanctuary, over the Bagini pass to the north, and though successful in climbing Trisul (23,360 ft.) he too failed to find a feasible route over the last few miles of the Rishi gorge, despite gallant attempts from both banks of the thundering, constricted river.

In 1926, 1927, and 1932, Hugh Ruttledge, I.C.S., then Deputy Commissioner of Almora in Kumaun and a mountain-enthusiast, tried three other approaches to the Inner Sanctuary; from the south and south-west, he was brought up short by the hanging-glaciers of Sunderdhunga Col and the glaciers below Trisul overlooking Nandakini River. From the north-east, up the Timphu glacier, the prospect was no easier and the party abandoned the attempt, Ruttledge remaining convinced of the uniqueness and attraction of the Sanctuary, and equally certain that the Blessed Goddess, Nanda Devi, was then beyond human capacity or endurance to approach because of the obstacles it imposed on its votaries.

It was Eric Shipton and H. W. Tilman in 1934 who had the privilege of pioneering a memorable route to the Inner Sanctuary by forcing a passage up the upper Rishi gorge after weeks of effort. They rounded off the trip by descending the treacherous and insecure ice-fall over Sunderdhunga Col to the south which had so frightened Ruttledge. One of their two sherpas, Angtarkey, still recalls that trip with righteous horror not unmixed with pride.

Since that first crossing, a survey party guided by Eric Shipton, and four expeditions to climb Nanda Devi have followed their route;

the French, who lost two climbers, in 1951, Major Jayal, who did not make the summit either, in 1955, and Mr. Gurdial Singh and the writer, accompanied by Major John Dias and others this year, in 1960 and 1961.

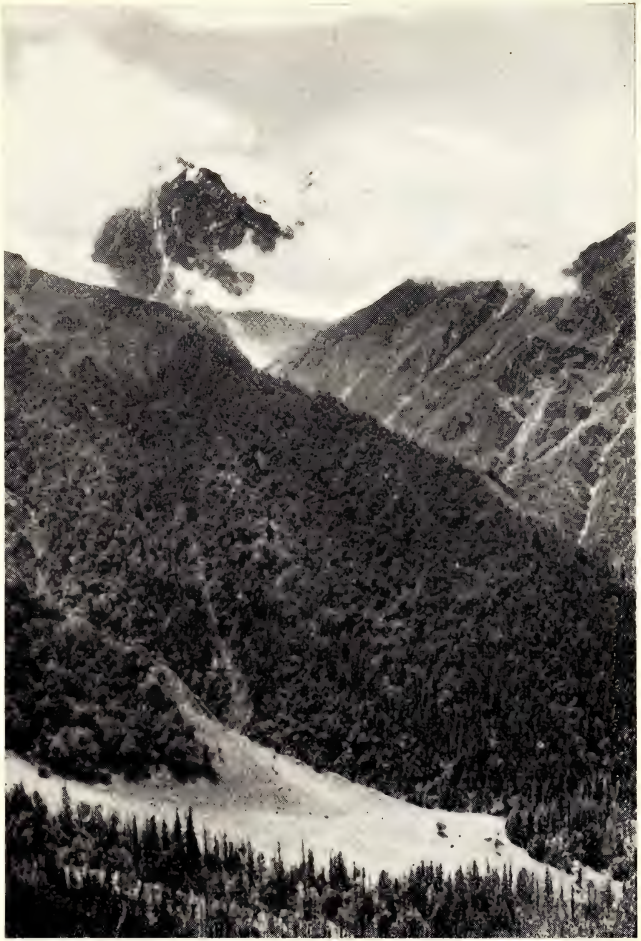
GEOGRAPHICAL AND ECOLOGICAL

The central Himalaya can roughly be described as that section lying between the river Sutlej in the west and the river Kali (Mahakali), the Sharda of the plains, in the east. The Goriganga is a right bank tributary of the latter and drains a very large glaciated area. The Alaknanda, of which the Dhauli is a left bank tributary, joins the Bhagirathi at Devprayag to form the Ganges of the plains. The Rishiganga is the major left-bank tributary of the Dhauli and runs roughly east to west, draining the vast system of glaciers within the Nanda Devi area which, including in the term both the Outer and the Inner Sanctuaries, coincides with the Rishi's watershed.

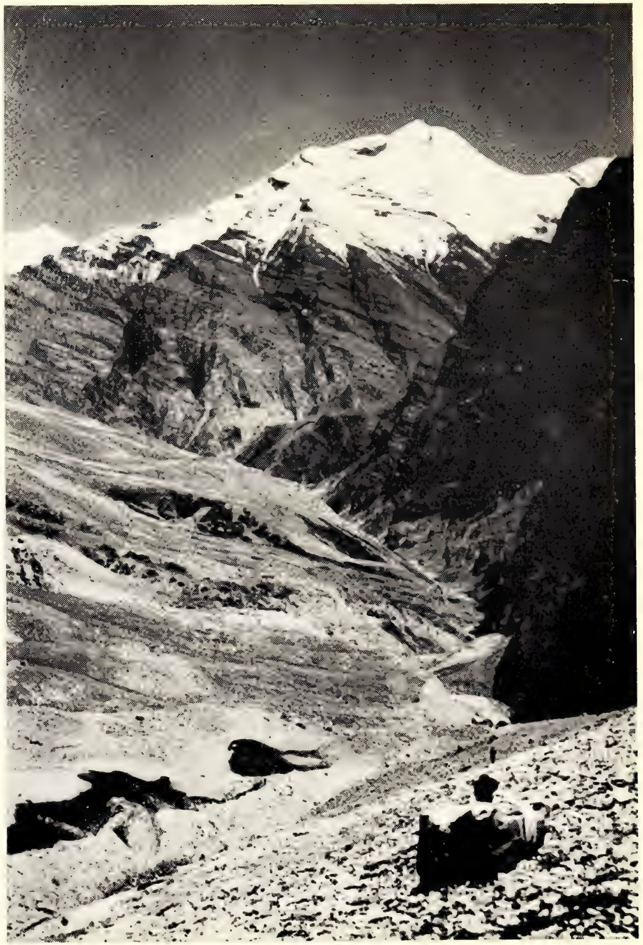
Nanda Devi stands like a reigning deity at the end of the ridge which may be said to represent the shorter central arm of an reversed letter E, the two outer arms representing the high ridges which enclose the inner arm. Two other arms enclose the two outer arms, and Dunagiri and Nanda Ghunti are the western terminations of the northern and the southern arm respectively.

Nanda Devi Khal (19,390 ft.), known popularly as Longstaff's Col because that doyen of Himalayan exploration first climbed it from the east, and Sunderdhunga Col (*c.* 18,000 ft.) are the only two passes ever crossed into the Inner Sanctuary, but both are out of question for all but expert climbers. The only route feasible is up the Rishi, and this is now fairly beaten up to the foot of the really impassable gorge, known as Rhamani because a torrent of that name joins the Rishi from the right bank there. Beyond this inner gorge lies the Inner Sanctuary, an area of nearly a hundred square miles of mountain and meadowland, gentle grassland, and rugged cliff faces, which is unique even in Himalayan experience, bearing as it does the indications of Divine handiwork. This was *terra incognita* even to the local shepherds and poachers, who would sacrifice the excellent musk-deer and Burrhel prospects inside rather than face either the difficulties and dangers of the gorge or the wrath of the Blessed Goddess who, they felt, would surely punish any such desecration of 'Dev-bhumi' (holy ground) by mortals.

Ecologically, the Nanda Devi Sanctuary, including the Outer Sanctuary, may be divided conveniently into the following types;

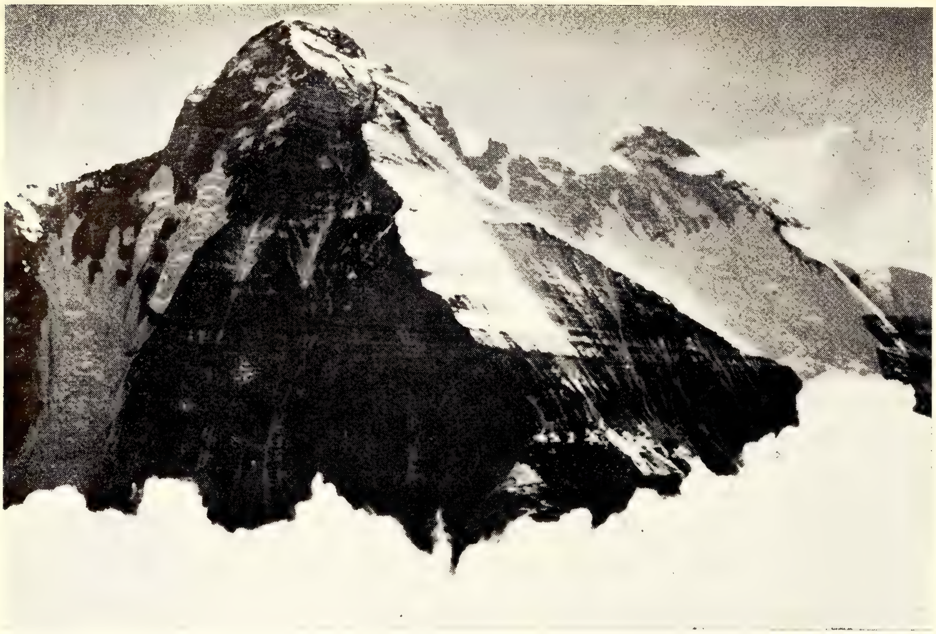


The Dibrugheba alp, amid temperate forests of Silver Birch, *Rhododendron campanulatum*, Spruce, and Cypress. One of the most beautiful spots in the Himalaya.



The Inner Sanctuary's grasslands, coming down to the southern Rishi at the base cliffs of Nanda Devi

(*Photos : Hari Dang*)



The main and east peaks of Nanda Devi. The climbing route used by expeditions lies up the ridge to the right of the main summit, merging into it tangentially.

Some more of the grasslands and mountain–scenery of the Inner Sanctuary

(*Photos : Hari Dang*)

1. Mixed-Temperate and Temperate forest, growing along hillsides and in sheltered re-entrants and warmer valleys to heights of 12,000 ft. Blue Pine, Deodar, Maple, and Horse Chestnut near the confluence of the Rishi with the Dhauli give way to Spruce, Cypress, Fir, Rhododendron (*R. campanulatum*), and Silver Birch higher up.

2. Temperate scrub continues above the tree-line, occasionally to as high as 15,000 ft., near the snow-line. Dwarf Rhododendron (*R. anthopogun* and *R. lepidotum*) and *Berberis*, *Cotoneaster*, and Juniper are the chief representatives of this class.

3. Alpine pastureland, varying in luxuriance from the lush and succulent, flower-rich alps of the lower areas to the scrawny, thin-soiled growth higher up. This kind of vegetation extends as high up as 18,000 ft., some mosses and pads extending a thousand feet higher in favoured locations, depending upon season and insolation.

In the Inner Sanctuary, especially where Silver Birch stands are few, there are extensive grasslands and excellent soil; villagers working for us have often expressed wistful longing to get their flocks up for the rich grazing, and been treated to cold looks from conservation-minded mountain-lovers. In addition there are miles of snowfields, rock faces, and ice-cliffs, of apparent uselessness yet invaluable as hallowed ground for the ardent mountaineer or nature-lover. Here, too, are lakes that no one has ever seen, hundreds of high and not-so-high mountains no one has ever climbed, passes that have yet to be crossed, and cliffs and valleys that are still sacred to their pristine inhabitants, the Burrhel and the Thar, the Snow Leopard and the Musk Deer, and other slippery, lonely-hearted, eagle-haunted crags and pastures, beyond the leap of goat, beyond the gaze of man, that still echo only to the shrill calls of the Monal and the melancholy whistle of the Snow Cock. No village or human habitation mars this pristine wilderness.

FLORA

Lacking expert scientific knowledge, I have not made any wide and detailed observations or checklists, but I have personally seen or photographed, or seen companions photograph over three hundred different flowers, and this in the short period between climbing and travelling.

ANIMAL LIFE

According to the Uttar Pradesh Forest Authorities, the entire area lying between the mountains Nanda Devi, Dunagiri, and Trisul is a

Game Sanctuary, in the sense that no one is permitted to shoot there and shooting-permits are not issued. In fact, this is a 'paper' Sanctuary, like its coeval the Govind Ballabh Pant Sanctuary in the Tons Basin in Garhwal. Both have never been visited or explored personally by the contemporary 'paper' forest officers, nor are likely to be visited in the near future. Poaching on a grand scale is normal in the Tons Basin, and not uncommon in the Rishi Basin. Musk Deer are the chief quarry, hunted ruthlessly and bravely by the poor villagers for the valuable musk-pod, which sells at lucrative rates in the Kumaun and Garhwal fairs. For, strange to relate, the Government has given complete protection to the Musk Deer and yet permits the export of large quantities of musk to dollar areas—at any rate, this was the situation till last year.[1]

Burrhel (*Ovis nahura*) abound all over the less rugged areas of the Rishi Basin, and often even over difficult terrain. Their numbers have dwindled greatly since Tilman and Shipton first saw large herds. This is largely the result of poaching by villagers in the Outer Sanctuary. Still, they are even now excessive for the limited feeding which the pastures offer. Sheep and goats from villages as far away as Wan give Burrhel keen competition, and may be spreading epidemics that might be decimating their numbers unknown to us. The tenet that the wilder the animal the less its resistance to infection from outside is only too true in this case. The Himalayan Thar (*Hemitragus jemlahicus*) is a very plentiful game animal in the basin, frequenting the most difficult terrain in the gorge of the Rishi, coming out into the grasslands only in the post-monsoon months for a spell before retreating to overhangs and precipices for the winter. This animal, too, is suffering decimation by meat-hungry villagers armed with new gun-licences. Even without guns, both Thar and Burrhel, more so the former, are vulnerable through their habit of coming to lower rock-faces when the snow lies deep on their summer haunts. Here they are cornered and chased by villagers and actually murdered with staves and spears. The means adopted to exhaust them before administering the coup, are many and ingenious, including lassoing them at night.

Musk Deer are still very plentiful, but are constantly molested, both by shikaris with guns and by shepherds with dogs, the latter being remorseless trackers of this highly odorous creature. Each time we went up the gorge, we met at least one large party of shikaris, who had had consistently successful hunting. One possible cause of the

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[1] The export of musk is still unrestricted.—EDS.

Musk Deer's abundance may be its greater propensity to take refuge in heights where even the shikaris dare not follow.

The Snow Leopard is another glorious animal which remains extraordinarily common, when a comparison is made with other mountain areas. This is not only the result of indifference from villagers, who are either too scared or too poor as marksmen to hunt him, but also of the abundance of Thar, Musk Deer, and Burrhel, its natural prey.

Though a few Black Bear have occasionally been seen, they are not common in the Rishi Valley, and this is only natural when the difficulty of terrain is considered.

Serow are not uncommon in the lower and less steep mixed-forests of the Dudh-ganga, Ronti-nala, and Sat-pula-nala. Streams like these, originating in the glaciers on either side of the Rishi abound, there being no fewer than twenty major and easily one hundred minor glaciers which feed the Rishi. All these subsidiary valleys have their own pastures and forests.

Snow-foxes, Marmots, musk-rats, and tailless rats abound.

Of bird life, Monal Pheasants, Snow Partridge, and Snow Cock are very common in their habitat. The Himalayan Rubythroat, seen at between 13,000 ft. and 16,000 ft., was a constant companion of base-camp off-days, serenading the occupants from the early hours of the morning.

The Blue Rock Thrush was encountered in pairs and parties of up to four couple, flying around above alpine grassland. The Himalayan Greenfinch, Hedge Sparrow, Redflanked Bush-Robin, Whitecapped and Plumbeous Redstart, the Stonechat, the Kashmir Whitethroated Dipper were some of the more interesting birds seen and clearly identified, while notes were compiled of birds seen but not clearly identified. Detailed observations were not made as time was short, and mountain-climbing the main objective.

The Lämmergeier or Bearded Vulture and the Golden Eagle were also seen. A large eagle (?) was seen in the act of swooping down and carrying off a Thar ewe.

PROSPECTS FOR THE FUTURE

Though hitherto known to only a few enthusiasts, it is not unlikely that the area will arouse—has in fact, already aroused—great curiosity and covetousness, the former among prospective tourists, the latter among villagers desirous of pasturage.

Having observed with deep and helpless regret what the 'paper' Forest Department has done to the Valley of Flowers further west (I refer to a four-foot high boundary wall which has been built to fence off a horticultural scheme for some vague medicinal plants, right across the valley), it is my intention that a similar programme be frustrated by forestalling the authorities by making a wiser suggestion to them which they cannot afford to ignore.

Poaching, rampant now, is bound to increase as the number of guns increases. Already the Milam and some other valleys of Kumaun and Garhwal have been shot clear of Musk Deer, Burrhel, and Thar, and skins of Burrhel and their young ones murdered in winter can be purchased for a few rupees in any hill fair or market-centre from Garbyang and Almora to Pipalkoti and Chamoli. In other mountain areas of India mountain game has been wiped out *en masse* by the army and the Border Police, and a likely increase in military activity in Garhwal would deal a like blow to mountain game here; hence the need for at least one region where not only the shooting of game but also the construction of monstrosities like the Bhyundar boundary wall can never occur. This requires something more than a Game Sanctuary status for the area and, in the current official mood of 'paper' sympathy for conservationist ideals, it would not be difficult to muster sufficient strength and momentum for the idea of a Rishi Wilderness Preserve to push through the necessary measure through Parliament, by which act alone can such a status be obtained.

SUMMING UP

Perhaps I am carried away by my enthusiasm for the Nanda Devi area, which has for long represented to me an unattainable ideal, an intensely personal wilderness reservoir. This need not detract from the value of this wilderness in its unspoilt and untampered condition. If we can retain the Rishi's Sanctuary without a motorable or even a bridle track, without boundary walls and Rest Houses, without official interference or tourist-huts—and I do not think of the next decade only, but of the next century, granted that we survive this decade—then perhaps those who do not migrate from the earth will find some consolation in its tranquil snows and mist-wreathed pastures, its stupendous screes and gentle swards. This is the true aim of this article, though an inadequate attempt has been made to cast it in a formal mould.

The Genus *Oedogonium* in Mysore State

BY

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(*With twelve figures*)

References to the occurrence in western India of genera and species which belong to the Oedogoniales have been few, as has been shown by the authors in a previous paper (*Gonzalves & Sonnad, 1957). In this paper, species of *Oedogonium* from various places in the Dharwar, Belgaum, and Karwar districts of Mysore State are recorded.

OEDOGONIACEAE

Genus **Oedogonium** Link

1. **Oedogonium suecicum** Wittr. ex Hirn, Acta Soc. Sci. fenn. 27 : 82, pl. 2, f. 15, 1900. Attached to aquatic plants in a small pool at Nagargali, September 1952.

2. **O. varians** Wittr. & Lund. ex Hirn, ibid. 27 : 89, pl. 4, f. 23, 24, 1900. In a small pool at Londa, September 1952.

3. **O. cardiacum** (Hass.) Wittr. ex Hirn var. **carbonicum** Wittr. ex Hirn, ibid. 27 : 87, pl. 4, f. 22, 1900. Attached to the leaves of rice plants in fields at Kyarkop, August 1951.

4. **O. franklinianum** Wittr. ex Hirn, ibid. 27 : 88, pl. 2, f. 18, 1900. In a pool at Naglavi, September 1951.

5. **O. glabrum** Hallas, Bot. Tidsskr. 26 : 408, f. 18, 1905. In a pool at Naglavi, September 1951.

6. **O. intermedium** Wittr. ex Hirn var. **szechwanense** Jao, Pap. Mich. Acad Sci. 19 : 89, pl. 6, f. 15-17, 1933/34. In a small pool at Londa, September 1952.

7. **O. fennicum** Tiff., Ohio J. Sci. 34 : 324, 1934. Attached to the leaves of rice plants in a field at Mugad, September 1951.

8. **O. hirnii** Gut. ex Hirn, Acta Soc. Sci. fenn. 27 : 93, pl. 5, f. 29, 1900. In a tank at Masur, April 1952.

9. **O. patulum** Tiff., Ohio J. Sci. 34 : 324, 1934. In a small pool at Gunji, January 1953.

10. **O. globosum** Nordst. ex Hirn, Acta Soc. Sci. fenn. 27 : 94, pl. 5, f. 30, 1900. In a tank near Gadag, January 1953.

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* Gonzalves, Ella A. & Sonnad, G. R. (1957). The Genus *Bulbochaete* in Western India. *J. Univ. Bom.* **25** (5) : 1-15.

11. **O. fragile** Wittr. ex Hirn, Acta Soc. Sci. fenn. 27; 96, pl. 5, f. 33 ; pl. 6, f. 34, 1900. In a small pool at Anmode, August 1952.

12. **O. fragile** var. **abyssinicum** Hirn, ibid. 27 : 97, pl. 6, f. 35, 1900. In a pool at Alnavar, September 1952.

13. **O. vaucherii** (Le Cl.) Al. Br.; Wittr. ex Hirn, ibid. 27 : 97, pl. 6, f. 36-38, 1900. In a pond at Tavargatti, September 1952.

14. **O. vaucherii** var. **parvum** var. nov. (f.1, a,b)

Monoica. Ut plurimum plantae paucis cellulis constantes. Cellulae vegetativae cylindricae; cellulae basales elongatae, terminales vero apicaliter acuminatae. Oogonia solitaria, globoso-ovoidea vel ovoidea ; poro superiore. Oosporae globosae vel subglobosae, oogonium haud implentes vel fere implentes ; parietes crassi et leves. Antheridia 1-5, subepigyna vel subhypogyna. Antherozoidea 2 ; divisio horizontalis.

Cellulae vegetativae 18-32 μ diam., 38-130 μ long.; oogonia 40-56 μ diam., 47-72 μ long.; oosporae 34-50 μ diam., 36-50 μ long.; antheridia 17-30 μ diam., 6-10 μ long.

Typus lectus in palude in loco Ranebennur, mense februario 1952, et positus in herbario auctoris senioris sub numero O.24.

The few-celled plants and the usually acuminate end cell differentiate this variety from the type.

15. **O. richterianum** Lemm. ex Hirn, Acta Soc. Sci. fenn. 27 : 117, pl. 12, f. 63, 64, 1900. Attached to aquatic plants in a pond at Bistenhatti, September 1952.

16. **O. pseudo-boscii** Hirn, ibid. 27 : 291, pl. 13, f. 67, 1900. In a pool at Khanapur, October 1952.

17. **O. oviforme** (Lew.) Hirn, ibid. 27 : 116, pl. 12, f. 62, 1900. In a pond at Tavargatti, September 1952. In a pool at Alnavar, September 1952.

18. **O. brevicingulatum** Jao var. **robustum** var. nov. (f. 2)

Monoica. Cellulae vegetativae robustae, cylindricae. Oogonia solitaria, ovoidea vel obovoidea ; poro superiore. Oosporae globosae vel subglobosae, haud penitus complentes oogonium; parietes sporae leves. Antheridia 1-3. Antherozoidea 2 ; divisio horizontalis.

Cellulae vegetativae 30-33 (-37) μ diam., 57-86 μ long.; oogonia 49-57 μ diam., 60-72 μ long.; oosporae 43-50 μ diam., 47-54 μ long.; antheridia 30-32 μ diam., 8-13 μ long.

Typus lectus natans in palude Nuggikeri, in loco Dharwar, mense februario 1952 et positus in herbario auctoris senioris sub numero O.27.

The oogonia, oospores and antheridia of this variety are longer than those of the type.

19. **O. martinicense** Hirn, Acta Soc. Sci. fenn. 27 : 134, pl. 16, f. 92, 1900. In a pond at Bistenhatti, September 1952.

20. **O. kurzii** Zell. ex Hirn, ibid. 27 : 135, pl. 16, f. 93, 1900. In a pond at Devarayi, October 1952.

21. **O. lageniforme** Hirn, ibid. 27 : 291, pl. 13, f. 68, 1900. Tiff., Brittonia, N. Y. 2 : 168, pl. 1, f. 16, 17. 1936. In a pond at Tinaighat, January 1953.

22. **O. ellipsoideum** Jao, Sinensia 8 : 305, pl. 3, f. 17-21, 1937. In slow-flowing water at Castle Rock, August 1951.

23. **O. plagiostomum** Wittr. ex Hirn, Acta Soc. Sci. fenn. 27 : 100, pl. 6, f. 39, 1900. In a pond at Nagargali, October 1951.

24. **O. diversum** (Hirn) Tiff., Ohio J. Sci. 34 : 324, 1934. In a pond at Londa, October 1952.

25. **O. majus** (Hansg.) Tiff., ibid. 34 : 324, 1934. In a pond at Devarayi, October 1952.

26. **O. oboviforme** Wittr. ex Hirn, Acta Soc. Sci. fenn, 27 : 141, pl. 20, f. 103, 1900. Attached to aquatic plants in a pool at Bistenhatti, September 1952.

27. **O. subrectum** Hirn, ibid. 27 : 141, pl. 20, f. 102, 1900. Attached to the leaves of rice plants in fields at Mugad, September 1952.

28. **O. landsboroughi** (Hass.) Wittr. ex Hirn, ibid. 27 : 135, pl. 16, 17, f. 94-96, 1900. In a small pool at Tavargatti, September 1952.

29. **O. crassum** (Hass.) Wittr. ex Hirn, ibid. 27 : 139, pl. 18, f. 99, 1900. In a pool at Tavargatti, September 1952.

30. **O. amplum** (Mag. & Wille) Tiff., Ohio J. Sci. 34 : 324, 1934. In a pond near Bistenhatti, January 1952.

31. **O. paludosum** (Hass.) Wittr. ex Hirn, Acta Soc. Sci. fenn. 27 : 120, pl. 13, f. 69, 1900. Attached to aquatic plants in a pond near Nagargali, September 1952.

32. **O. carolianum** Tiff., Ohio J. Sci. 34 : 324, 1934. In a small pool at Kambarganvi, September 1952.

33. **O. leiopleurum** Nordst. & Hirn in Hirn, Acta Soc. Sci. fenn. 27 : 126, pl. 14, f. 79, 1900. Attached to the leaves of rice plants in fields at Mugad, September 1952.

34. **O. arcyosporum** Nordst. & Hirn in Hirn, ibid. 27 : 104, pl. 7, f. 44, 1900. In a pool at Londa, September 1952. In a pond at Gunji, September 1952.

35. **O. areolatum** Lag. ex Hirn var. **elongatum** var. nov. (f. 3 a, b)

Dioica, macrandra. Cellulae vegetativae cylindricae ; cellulae femineae masculis largiores. Oogonia 1-2, obovoidea vel ovoidea ; poro superiore. Oosporae globoso-ovoideae vel ovoideae, haud complentes oogonium longitudinaliter, series media parietum sporarum areolata ; interior et exterior series leves. Antheridia 3-8. Antherozoidea 2 ; divisio horizontalis.

Cellulae vegetativae femineae 18-21 μ diam., 130-220 μ long. ; cellulae vegetativae masculae 14-19 μ diam., 100-201 μ long. ; oogonia 50-56 μ diam., 70-90 (-108) μ long. ; oosporae 49-51 μ diam., 60-70 μ long. ; antheridia 13-17 μ diam., 8-11 μ long.

Typus lectus in uligine ad Khanapur, mense octobri 1952 et positus in herbario auctoris senioris sub numero O.52.

The vegetative cells, oogonia and oospores of the above variety are longer than those of the type.

36. **O. dictyosporum** Wittr. ex Hirn, Acta Soc. Sci. fenn. 27 : 103, pl. 7, f. 43. 1900. In a pool at Mugad, August 1951.

37. **O. subareolatum** Tiff., Brittonia, N. Y. 2 : 168, pl. 1, f. 13-15, 1936. In a pool at Alnavar, September 1951.

38. **O. foveolatum** Wittr. ex Hirn, Acta Soc. Sci. fenn. 27 : 106, pl. 7, f. 46, 1900, In a pool at Yellapur, September 1949.

39. **O. excavatum** Jao var. **minus** var. nov. (f. 4)

Monoica. Cellulae vegetativae cylindricae. Oogonia solitaria, globosa vel ovoideo-globosa ; poro superiore. Oosporae globosae, oogonium complentes, series media parietum scrobiculata, interior atque exterior series leves. Antheridia 2-3, subepigyna. Antherozoidea 2 ; divisio horizontalis.

Cellulae vegetativae 9-13 μ diam., 40-93 μ long. ; oogonia 38-41 μ diam., 40-50 μ long. ; oosporae 34-40 μ diam., 33-40 μ long. ; antheridia 7-11 μ diam., 7-9 μ long.

Typus lectus in oryzetis ad Kogilgeri, mense septembri 1952 et positus in herbario auctoris senioris sub numero O.56.

The variety described above is smaller than the type.

40. **O. wyliei** Tiff., Trans. Amer. micros. Soc. 45 : 90, pl. 1, f. 1-4, 1926. In rice fields at Chendie, near Karwar, December 1951. In a pond at Bistenhatti, February 1952.

41. **O. santurcense** Tiff., Brittonia, N.Y. 2 : 168, pl. 1, f. 20-22, 1936. In a rice field at Bistenhatti, September 1952.

42. **O. spinosum** sp. nov. (f. 5 a-c)

Dioica, macrandra. Cellulae vegetativae cylindricae, masculae et femineae cellulae eiusdem diametri; cellulae basales elongatae, terminales vero apicaliter obtusae. Oogonia solitaria, obovoideo-globosa vel ovoidea; poro superiore. Oosporae globosae, haud implentes oogonium; exterior series parietum spinulis magnis ornata, interior vero levis. Antheridia 1-3. Antherozoidea 2; divisio horizontalis.

Cellulae vegetativae 14-22 μ diam., 70-115 μ long.; oogonia 46-47 μ diam., 52-56 μ long.; oosporae 38-43 μ diam., 38-44 μ long.; antheridia 14-19 μ diam., 6-9 μ long.

Typus lectus in oryzetis ad Naglavi, mense octobri 1951 et positus in herbario auctoris senioris sub numero O.60.

The only other dioecious macrandrous species with oogonia opening by a superior pore and with the wall of the oospores spiny is *O. santurcense.* The latter differs from the species described above in dimensions. Moreover, the spines on the wall of the oospores of this species are large and rather sparse, while they are fine and closely arranged in *O. santurcense.*

43. **O. pseudacrosporum** Wittr. ex Hirn, Acta Soc. Sci. fenn. 27 : 193, pl. 32, f. 196, 1900. In a pond at Kogilgeri, September 1951.

44. **O. paucostriatum** Tiff., Ohio J. Sci. 34 : 325, 1934. Attached to aquatic plants in a pond at Bistenhatti, September 1952.

45. **O. costatosporum** Jao, Rhodora 36 : 88, pl. 6, f. 8-10, 1934. In a rice field at Mugad, September 1951. In a pond at Mundgod, September 1950.

46. **O. costatosporum** var. **longisporum** var. nov. (f. 6 a-c)

Dioica, macrandra. Cellulae vegetativae cylindricae, eae quidem prope apicem longissimae et angustae, basales vero breves et robustae. Oogonia solitaria, subellipsoidea vel ellipsoidea, operculata ; divisio superior. Oosporae ellipsoideae, fere implentes oogonium ; series media parietis costis 25-30 ornata, series vero externa atque interna leves. Antheridia non visa.

Cellulae vegetativae 7-19 μ diam., 72-190 μ long.; cellulae basales 21-27 μ diam., 79 μ long.; oogonia 38-44 μ diam., 68-96 (-105) μ long.; oosporae 32-43 μ diam., 57-74 μ long.

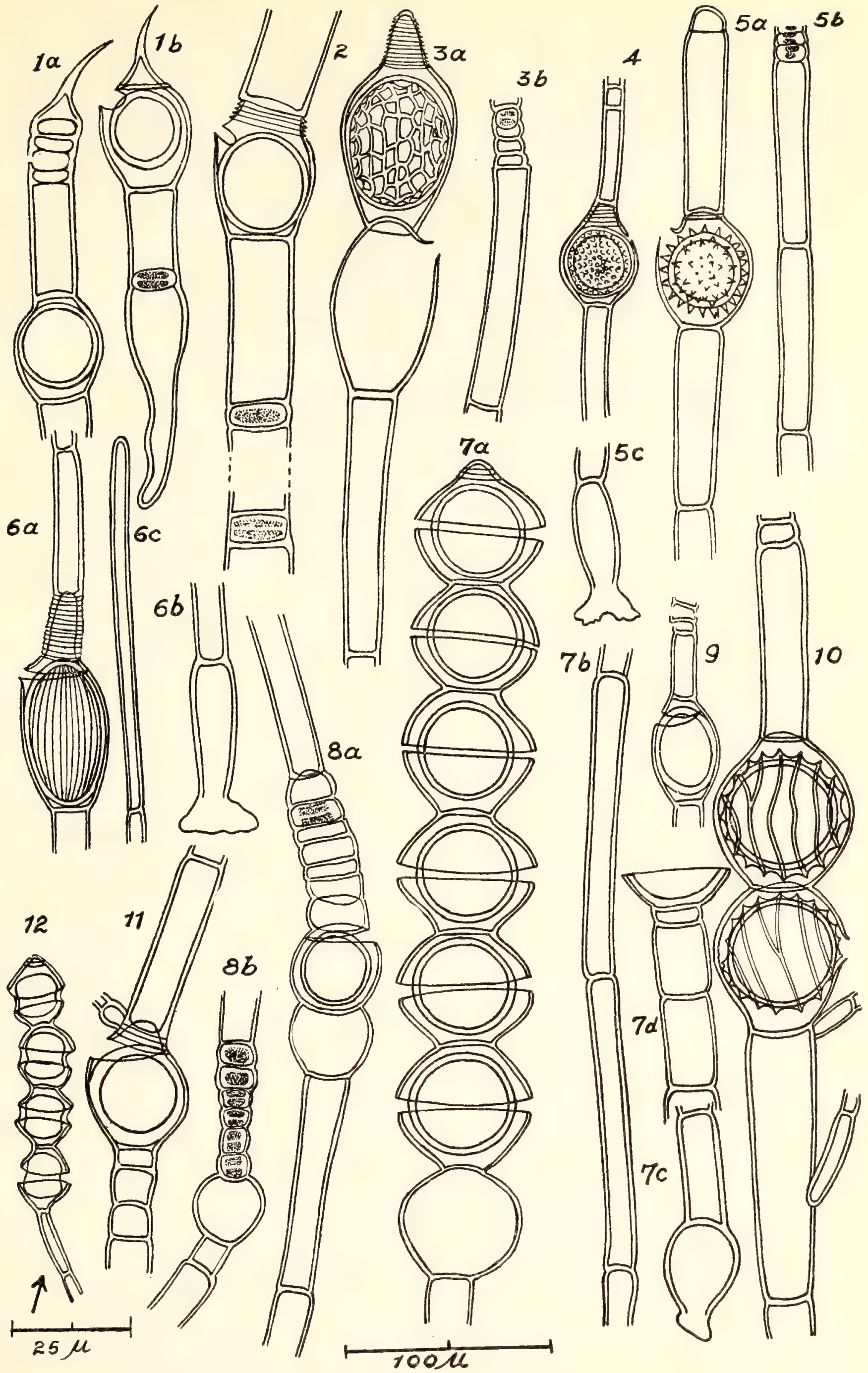

Fig. 1. *a*, *b*. *Oedogonium vaucherii* var. *parvum* var. nov.; Fig. 2. *O. brevicingulatum* var. *robustum* var. nov.; Fig. 3. *O. areolatum* var. *elongatum* var. nov.: *a*. Part of a female plant; *b*. Part of a male plant; Fig. 4. *O. excavatum* var. *minus* var. nov.; Fig. 5. *O. spinosum* sp. nov.: *a*. Part of a female plant; *b*. Part of a male plant; *c*. Basal cell; Fig. 6. *O. costatosporum* var. *longisporum* var. nov.: *a*. Part of a female plant; *b*. Basal cell; *c*. Terminal cell; Fig. 7. *O. bharatense* sp. nov.: *a*. Series of oogonia; *b*. Cells near the apex of the filament; *c*. Basal cell; ***d***. An antheridium; Fig. 8. *a*, *b*. *O. variabile* sp. nov. Filaments with antheridia of varying sizes; Fig. 9. *O. kirchneri* var. *majus* var. nov.; Fig. 10. *O. illinoisense* var. *indicum* var. nov.; Fig. 11. *O. laetevirens* var. *amplum* var nov.; Fig. 12. *O. pusillum* var. *minus* var. nov.

Typus lectus in piscina ad Nagargali, mense septembri 1952 et positus in herbario auctoris senioris sub numero O.65.

The longer oogonia and oospores as well as the longer and narrower vegetative cells towards the apex of the filaments differentiate this variety from the type.

47. **O. nobile** Wittr. ex Hirn, Acta Soc. Sci. fenn. 27: 189, pl. 30, f. 188, 1900. In a pond at Bistenhatti, September 1952.

48. **O. pratense,** Trans.-Amer. J. Bot. 1: 297, pl. 29, f. 9-12, 1914. In a tank near Naglavi, September 1952.

49. **O. bharatense** sp. nov. (f. 7 a-d)

Monoica. Cellulae vegetativae supra cellulas basales angustae, tenues et capitellatae, eae quidem prope oogonium latae et breves. Oogonia 1-8, globosa vel depresso-globosa ; operculata, divisio media, lata. Oosporae globosae, haud implentes oogonium ; parietes leves. Antheridia ut plurimum solitaria, hypogyna vel intercalaria. Antherozoidea 2 ; divisio horizontalis.

Cellulae vegetativae 13-28 μ diam., 34-150 μ long.; oogonia 55-72 μ diam., 50-63 μ long.; oosporae 43-50 μ diam., 43-50 μ long.; antheridia 26-28 μ diam., 11-28 μ long.

Typus lectus in puteo neglecto ad Gunji, mense januario 1952 et positus in herbario auctoris senioris sub numero O.73.

This species resembles *O. indicum* Hirn at first sight, but the latter is dioecious nannandrous. The difference in the size and form of the upper and lower vegetative cells of this species is also distinctive.

50. **O. mitratrum** Hirn, Acta Soc. Sci. fenn. 27 : 302, pl. 24, f. 132, 1900. Attached to the leaves of rice plants in fields near Tinaighat, October 1951.

51. **O. welwitschii** West & West ex Hirn, ibid. 27 : 174, pl. 28, f. 162, 1900. In rice fields in the village of Chendi, near Karwar, December 1951.

52. **O. pringsheimii** Cram. ; Wittr. ex Hirn, ibid. 27 : 170, pl. 27, f. 155, 1900. In Kelgeri Tank, Dharwar, September 1951. In a small pond in the jungle near Devarayi, September 1952.

53. **O. pringsheimii** var. **nordstedtii** Wittr. ex Hirn, ibid. 27 : 171, pl. 27, f. 156-158, 1900. In Nuggikeri Tank, Dharwar, February 1952.

54. **O. abbreviatum** (Hirn) Tiff., Ohio J. Sci. 34 : 325, 1934. In a pond at Alnavar, September 1951.

55. **O. epiphyticum** Trans. & Tiff., in Tiff., ibid. 34 : 325, 1934. In a ditch at Devarayi, September 1952.

56. **O. simplex** Hirn, Acta Soc. Sci. fenn. 27 : 158, pl. 24, f. 135, 1900. In a pool at Haliyal, October 1949.

57. **O. pyrulum** Wittr. ex Hirn, ibid. 27: 158, pl. 25, f. 136, 1900. In a ditch at Londa, September 1952. In a pond at Nagargali, September 1952.

58. **O. pithophorae** Wittr. ex Hirn, ibid. 27: 157, pl. 24, f. 134, 1900. In a pool at Devarayi, September 1952.

59. **O. variabile** sp. nov. (f. 8 a, b)

Monoica. Cellulae vegetativae cylindricae. Oogonia 1-2, globosa, subglobosa vel obovoideo-globosa ; operculata, divisio superior. Oosporae globosae vel subglobosae, haud implentes oogonium ; parietes leves. Antheridia 1-7, epigyna vel hypogyna, latitudinis variabilis. Antherozoidea 2 ; divisio horizontalis.

Cellulae vegetativae 16-20 μ diam., 28-101 μ long. ; oogonia 34-39 (-44) μ diam., 34-45 μ long. ; oosporae 29-37 μ diam., 29-39 μ long. ; antheridia 13-20 μ diam., 9-15 μ long. ; et 24-29 μ diam., 11-20 μ long.

Typus lectus in palude ad Desur, mense octobri 1952 et positus in herbario auctoris senioris sub numero O.78.

This species resembles *O. autumnale* Wittr. ex Hirn, but can be distinguished from it by the smaller oogonia and the varying sizes of the antheridia.

60. O. **obesum** (Wittr.) Hirn, Acta Soc. Sci. fenn. 27 : 166, pl. 26, f. 148, 1900. In a pond at Bistenhatti, January 1952.

61. O. **crispum** (Hass.) Wittr. ex Hirn, ibid. 27 : 159, pl. 25, f. 138, 139, 141, 1900. In a pond at Yellapur, September 1952.

62. O. **crispum** var. **gracilescens** Wittr. ex Hirn, ibid. 27 : 162, pl. 25, f. 143, 144 ; pl. 26, f. 144, 1900. In a tank near Nagargali, September 1952.

63. O. **crispum** var. **uruguayense** Mag. & Wille ex Hirn, ibid. 27 : 164, pl. 26, f. 145, 146, 1900. In a pond at Tavargatti, September 1952. Attached to aquatic plants in a pond at Nagargali, September 1952.

64. O. **crispum** var. **hawaiense** Nordst. ex Hirn, ibid. 27 : 165, pl. 26, f. 147, 1900. In a puddle in the jungle near Londa, September 1952.

65. O. **rupestre** Hirn, ibid. 27 : 168, pl. 26, f. 152, 1900. In a small pool at Nagargali, September 1952.

66. O. **rupestre** f. **pseudautumnale** Hirn, ibid. 27 : 169, pl. 27, f. 153, 1900. In a puddle near the railway lines between Londa and Devarayi, September 1951.

67. O. **kirchneri** Wittr. ex Hirn var. **majus** var. nov. (f. 9)

Monoica. Cellulae vegetativae cylindricae. Oogonia solitaria, ovoidea vel ovoideo-ellipsoidea, operculata; divisio superior. Oosporae globoso-ellipsoideae vel ovoideo-ellipsoidea, fere implentes oogonium ; parietes leves. Antheridia 1-3, hypogyna vel subepigyna. Antherozoidea 2 ; divisio horizontalis.

Cellulae vegetativae 13-16 μ diam., 28-56 μ long. ; oogonia 28-36 μ diam., 43-52 μ long. ; oosporae 24-34 μ diam., 40-47 μ long. ; antheridia 11-14 μ diam., 6-10 μ long.

Typus lectus in vado ad Gunji, septembri 1952 et positus in herbario auctoris senioris sub numero O.104.

The larger oogonia and oospores and the occasional subepigynous antheridia, in addition to hypogynous ones, differentiate this variety from the type.

68. O. **gracillimum** Wittr. & Lund. ex Hirn, Acta Soc. Sci. fenn. 27: 184, pl. 29, f. 180, 1900. In a pond near Nagargali, September 1952.

69. O. **oblongellum** Kirch. ex Hirn, ibid. 27: 182, pl. 29, f. 177, 1900. Attached to aquatic plants in a pond at Naglavi, September 1952.

70. O. **hallasiae** Tiff., Ohio J. Sci. 34 : 325, 1934. In a pond at Khanapur, September 1950.

71. O. **undulatum** (Breb.) Al. Br. ; Wittr. ex Hirn, Acta Soc. Sci. fenn. 27 : 257, pl. 45, f. 273-275, 1900. In a pool at Londa, September 1951.

72. O. **undulatum** f. **senegalense** (Nordst.) Hirn, ibid. 27 : 261, pl. 45, f. 276, 277, 1900. In a tank at Godgeri, January 1952.

73. **O. aster** Wittr. ex Hirn, Acta Soc. Sci. fenn. 27 : 198, pl. 32, f. 202, 1900. In a pond at Tavargatti, August 1951.

74. **O. exospirale** Tiff., Ohio J. Sci. 24 : 184, pl. 2, f. 1-3, 1924. In a pond at Nagargali, August 1951.

75. **O. illinoisense** Trans. var. **indicum** var. nov. (f. 10)

Dioica, nannandra, gynandrospora. Cellulae vegetativae cylindricae, cellulae suffulcientes paulum dilatatae. Oogonia 1-2, subglobosa vel obovoideo-globosa ; poro medio. Oosporae globosae vel subglobosae, fere implentes oogonium ; externa series muralis sporae spiraliter costata, costis 5-8 in aspectu optico. Androsporangia 2-4, ut plurimum subepigyna. Mares nani cellulis suffulcientibus insidentes. Antheridia externa.

Cellulae vegetativae 17-22 μ diam., 70-130 μ long.; cellulae suffulcientes 23-33 μ diam., 100-133 μ long.; oogonia 65-68 μ diam., 69-72 μ long.; oosporae 60-66 μ diam., 60-67 μ long.; androsporangia 17-19 μ diam., 17-19 μ long.; marium nanorum stipites 7-12 μ diam., 20-27 μ long.

Typus lectus in vado ad Londa, mense septembri 1953 et positus in herbario auctoris senioris sub numero O.114.

The diameters of the vegetative cells, oogonia, oospores and androsporangia are greater than those of the type, while the suffultory cells are less in diameter, but longer.

76. **O. spirale** Hirn, Acta Soc. Sci. fenn. 27 : 201, p1.33, f. 206, 1900. In a puddle at Alnavar, September 1952.

77. **O. spirale** var. **majus** Singh, Proc. Indian Acad. Sci. 8 : 38, f. 4 A-C., 1938. In a pond near Bistenhatti, October 1952.

78. **O. latviense** Tiff., Ohio J. Sci. 34 : 325, 1934. In a small pool at Mundgod, September 1952.

79. **O. subsexangulare** Tiff., ibid. 34 : 325, 1934. In a pool along the railway lines near the Devarayi railway station, September 1952.

80. **O. stellatum** Wittr. ex Hirn, Acta Soc. Sci. fenn. 27 : 205, pl. 34, f, 210, 1900. In a pool near Castle Rock, August 1952.

81. **O. alternans** Wittr. & Lund. ex Hirn, ibid. 27 : 251, pl. 42, f. 263, 1900. In a tank at Godgeri, September 1952.

82. **O. armigerum** Hirn, ibid. 27 : 203, pl. 33, f. 208, 1900. In a pond at Devarayi, August 1952.

83. **O. cyathigerum** Wittr. ex Hirn, ibid. 27 : 252, pl. 43, f. 265, 266, 1900. Attached to the decaying leaves of rice plants in a field at Mugad, September 1952.

84. **O. wolleanum** Wittr. ex Hirn, ibid. 27 : 220, pl. 37, f. 226, 1900. In a tank at Yellapur, September 1951. In a pond at Devarayi, September 1952.

85. **O. concatenatum** (Hass.) Wittr. ex Hirn, ibid. 27 : 223, pl. 38, f. 230, 1900. In a pond near Nagargali, September 1952.

86. **O. hispidum** Nordst. ex Hirn, ibid. 27 : 210, pl. 35, f. 215, 1900. In a pond at Khanapur, September 1952.

87. **O. elegans** West & West, Trans. Linn. Soc. Lond. (Bot.) 6 : 128, pl. 17, f. 6, 7, 1902 In stretches of shallow water at Alnavar, November 1951.

88. **O. elegans** var. **americanum** Jao, Rhodora 36 : 204, pl. 288, f. 28-30, 1934. In a pond near Londa, September 1952.

89. **O. indicum** Hirn, Acta Soc. Sci. fenn. 27 : 269, pl. 46, f. 288, 1900. Attached to the leaves of rice plants in fields at Tavargatti, September 1952.

90. **O. confertum** Hirn, ibid. 27 : 272, pl. 46, f. 291, 1900. In a pond at Tavargatti, December 1951.

91. **O. perspicuum** Hirn, ibid. 27 : 273, pl. 46, f. 293, 1900. In Nuggikeri Tank, Dharwar, January 1952.

The specimens were definitely idioandrosporous. The androsporangia were 1 to 8-seriate.

92. **O. oelandicum** Wittr. ; Hirn, ibid. 27 : 273, pl. 47, f. 297, 1900. Attached to the leaves of rice plants in a field near Kambarganvi, August 1951.

93. **O. platygynum** Wittr. ex Hirn var. **ambiceps** Jao, Rhodora 36 : 208, pl. 287, f. 26, 27, 1934. In a pond at Alnavar, January 1952.

94. **O. senegalense** (Nordst.) Tiff., Ohio J. Sci. 34 : 326, 1934. In a rice field at Naglavi, October 1951.

95. **O. decipiens** Wittr. ex Hirn, Acta Soc. Sci. fenn. 27 : 266, pl. 46, f. 283, 284, 1900. In a pool at Belgaum, October 1952. In rice fields at Kyarkop, September 1952.

96. **O. decipiens** var. **dissimile** (Hirn) Tiff., N. Amer. Flora 11 : 68, pl. 24, f. 384, 385, 1937. In a pool at Dandeli, October 1953.

97. **O. decipiens** var. **bernardense** (Bates) Hirn, Acta Soc. Sci. fenn. 27 : 268, pl. 46, f. 286, 1900. In a pool at Khanapur, September 1952.

98. **O. rugulosum** Nordst. ex Hirn, bid. 27 : 241, pl. 40, f. 249, 250, 1900. In a ditch at Belgaum, October 1952.

99. **O. laetevirens** Wittr. ex Hirn var. **amplum** var. nov. (f. 11)

Dioica, nannandra, gynandrospora. Cellulae vegetativae cylindricae, Oogonia solitaria, globosa vel obovoideo-globosa; operculata, divisio superior. Oosporae globosae, oogonium implentes; parietes leves. Androsporangia 2-3, subepigyna vel hypogyna. Mares nani oogoniis insidentes. Antheridia externa.

Cellulae vegetativae 14-23 μ diam., 50-80 μ long. ; cellulae basales 23 μ diam., 65 μ long. ; oogonia 43-50 μ diam., 44-56 μ long. ; oosporae 39-48 μ diam., 39-48 μ long. ; androsporangia 14-23 μ diam., 10-21 μ long. ; marium nanorum stipites 10-12 μ diam., 19-22 μ long.

Typus lectus in palude ad Gunji, mense octobri 1952 et positus in herbario auctoris senioris sub numero O.151.

The above variety is much larger than the type.

100. **O. implexum** Hirn, Acta Soc. Sci. fenn. 27 : 283, pl. 49, f. 316, 1900. In stretches of shallow water at Alnavar, January 1952.

101. **O. monile** Berk. & Harv. ex Hirn, ibid. 27 : 229, pl. 38, 39, f. 235, 236, 1900. In a pool at Desur, August 1952.

102. **O. eminens** (Hirn) Tiff., Ohio J. Sci. 34 : 326, 1934. In a strip of shallow water at Khanapur, October 1952.

103. **O. exomonile** Tiff., ibid. 34 : 326, 1934. In a pool at Londa, August 1951.

104. **O. obtruncatum** Wittr. ex Hirn, Acta Soc. Sci. fenn. 27 : 284, pl. 49, f. 318, 1900. Attached to aquatic plants in a pool at Alnavar, September 1952.

105. **O. tapeinosporum** Wittr. ex Hirn, ibid. 27 : 297, pl. 23, f. 117, 1900. In rice fields at Karwar, December 1951.

106. **O. inconspicuum** Hirn, ibid. 27 : 296, pl. 23, f. 116, 1900. In a small pool at Devarayi, September 1952.

107. **O. pusillum** Kirch. ex Hirn, ibid. 27 : 299, pl. 24, f. 125, 1900. In a strip of shallow water at Alnavar, September 1952.

108. **O. pusillum** var. **minus** var. nov. (f. 12)

Cellulae vegetativae cylindricae. Oogonia solitaria, subconico-ellipsoidea vel subconico-globosa ; operculata, divisio media, lata. Oosporae subglobosae atque tenuiter constrictae ad medium, haud penitus implentes oogonium ; parietes leves.

Cellulae vegetativae 2.5-4.5 μ diam., 10-21 μ long.; oogonia 10-14 μ diam., 11-16 μ long.; oosporae 9-11 μ diam., 10-12.5 μ long.

Typus lectus in palude ad Alnavar, mense januario 1953 et positus in herbario auctoris senioris sub numero O.170.

This variety is smaller than the type, while the oogonia are not solitary or in twos, but are up to 4-seriate.

109. **O. inclusum** Hirn, Acta Soc. Sci. fenn. 27: 318, pl. 50, f. 324, 1900. Attached to aquatic plants in a pond at Haliyal, September 1952.

110. **O. selandiae** Hallas, Bot. Tidsskr. 26 : 496, f. 14, 1905. Attached to aquatic plants in a pond at Naglavi, September 1952.

111. **O. flexuosum** Hirn, Acta Soc. Sci. fenn. 27 : 313, pl. 48, f. 310, 1900. Attached to aquatic plants in Kempkeri Tank, near Dharwar, August 1952.

112. **O. virceburgense** Hirn, ibid. 27: 301, pl. 24, f. 128, 1900. In a pond near Khanapur, February 1952.

Occasionally oogonia up to 14-seriate were found.

113. **O. calvum** Wittr. ex Hirn, ibid. 27 : 316, pl. 50, f. 323, 1900. In a rice field near Kambarganvi, September 1952.

114. **O. pseudospirale** Nyg., Trans. roy. Soc. S. Afr. 20 : 136, f. 32, 1932. In a tank near Tavargatti, September 1952.

ACKNOWLEDGEMENT

The authors are deeply grateful to Rev. Fr. H. Santapau, S.J., Ph.D. for the Latin diagnoses of the new types.

Entomological Survey of Himalaya

Part XXVI. A Contribution to our Knowledge of the Geography of the High Altitude Insects of the Nival Zones from the North-West Himalaya

PART 2

BY

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(*With nine text-figures*)

[*Continued from Vol.* **58** (2) : 406]

COLEOPTERA

We have given some account of the distribution of Coleoptera from the NW. Himalaya in an earlier paper (99). The order represents about 49% of the total nival insect fauna (Table I; Fig. 3). About 190 species belonging to 18 families are so far known (Table II; Fig. 12).

Species endemism is 59%. Nearly 96% of the species are Palaearctic (Tables III and X); of these about 3% represent the Mediterranean elements. About 5% of the species extend to the Nearctic realm. Nearly half the species occur north of the crest line of the Great Himalaya.

Carabidae, Staphylinidae, Tenebrionidae and Curculionidae are the dominant families. Analysis of the faunal component elements is summarized in Table III and the percentage composition of the four dominant families in Table IV (Fig. 13).

The family Carabidae, with 84 species belonging to 27 genera, represents about 45.3% of the total nival Coleoptera above the timber line. Of these, 33 species (under 10 genera) occur above an elevation of 4000 m. above m.s.l. Nearly half the species are endemites. Of the endemic species, 4 fall under the genus *Amara*, 15 under *Bembidion*, 4 each under *Carabus* and *Cymindis*, and 2 under *Nebria*.

TABLE II

Analysis of the abundance of species in different families of nival Coleoptera

Serial No.	Family	No. of Species	Percentage in total nival Coleoptera
1.	Cicindelidae	1	0.52
2.	Carabidae	84	45.30
3.	Dytiscidae	7	4.16
4.	Hydrophilidae	7	4.16
5.	Histeridae	2	1.04
6.	Staphylinidae	32	16.60
7.	Cantharidae	1	0.52
8.	Meloidae	1	0.52
9.	Elateridae	1	0.52
10.	Coccinellidae	2	1.04
11.	Tenebrionidae	17	8.80
12.	Scarabaeidae	3	2.08
13.	Geotrupidae	1	0.52
14.	Aphodidae	1	0.52
15.	Rutelidae	2	1.04
16.	Cerambycidae	4	2.08
17.	Chrysomelidae	4	2.08
18.	Curculionidae	16	8.30
	Total nival species	186	

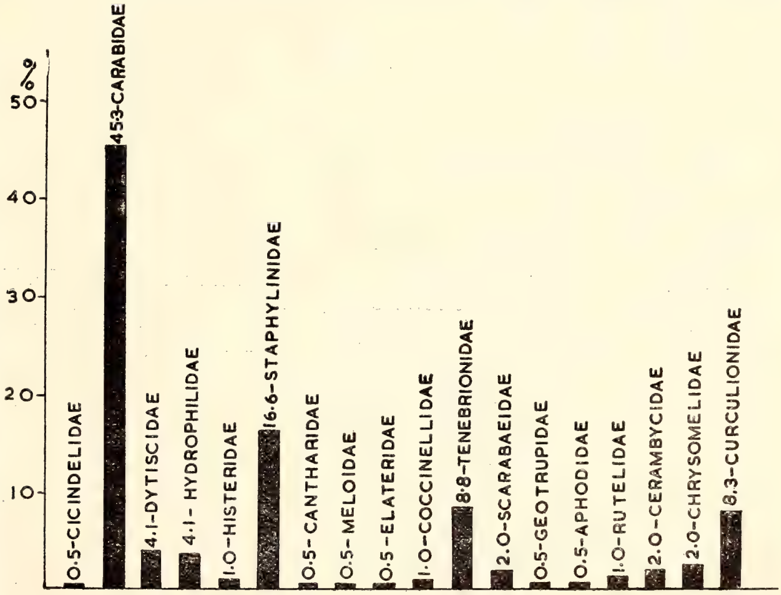


Fig. 12. The nival Coleoptera from the north-west Himalaya.

The endemites *Bembidion pictum* (Fald.), *Bembidion hutchinsoni* Andr., *Bembidion irregulare* Net., *Bembidion ixion* Andr., *Bembidion*

TABLE III

Faunal elements of the nival Coleoptera

Serial No.	Family	Total Species	Endemites	Palaearctic		Oriental (Indo-Malayan)	Remarks
				Total	Medit.		
1.	Cicindelidae	1	—	1	1	—	
2.	Carabidae	84	44	81	3	4	2 spp. extend to Nearctic; 1 sp. wide-spread.
3.	Dytiscidae	7	4	7	—	—	
4.	Hydrophilidae	7	1	7	—	—	
5.	Histeridae	2	1	2	—	—	
6.	Staphylinidae	32	26	32	1	—	
7.	Cantharidae	1	—	1	—	—	
8.	Meloidae	1	—	—	—	1	
9.	Elateridae	1	—	1	—	—	
10.	Coccinellidae	2	—	2	—	—	
11.	Tenebrionidae	17	16	17	—	—	
12.	Scarabaeidae	3	—	3	—	—	
13.	Geotrupidae	1	1	1	—	—	
14.	Aphodidae	1	1	1	—	—	
15.	Rutelidae	2	1	2	—	—	
16.	Cerambycidae	4	1	4	—	—	
17.	Chrysomelidae	4	1	4	—	—	
18.	Curculionidae	16	12	14	—	—	
	Total	186	109	180	5	5	
	Percentage out of total 186 species		58.8%	95.3%	—	4.1%	
	Percentage of the Mediterranean elements in the total Palaearctic				3.0%		

TABLE IV

Percentage of the faunal component elements in the four dominant families of nival Coleoptera

Serial No.	Family	Total species	Endemites	Palaearctic		Indo-Malayan
				Total	Medit.	
1.	Carabidae	84	52.0	98.0	4.8	2.0
2.	Staphylinidae	32	81.2	100.0	3.1	—
3.	Tenebrionidae	17	94.0	100.0	—	—
4.	Curculionidae	16	75.0	87.5	—	12.5

ladas Andr., *Bembidion leve* Andr., and *Bembidion livens* Andr. are strictly localized in the area drained by R. Indus north of the crest line of the Great Himalaya, and also mostly occur at elevations above 4000 m. *B. pictum* (Fald.), *B. hutchinsoni* Andr., *B. ladas* Andr., and *B. leve* Andr. are never found below an elevation of 4000 m. *B. hutchinsoni* Andr., found at 4734 m., represents at present the maximum altitude record in the genus *Bembidion* in the NW. Himalaya. Three species *B. algidum* Andr., *B. caporoaccoi* Net., and *B. irregulare* Net. often descend below 3000 m. to within the fringe of the taiga.

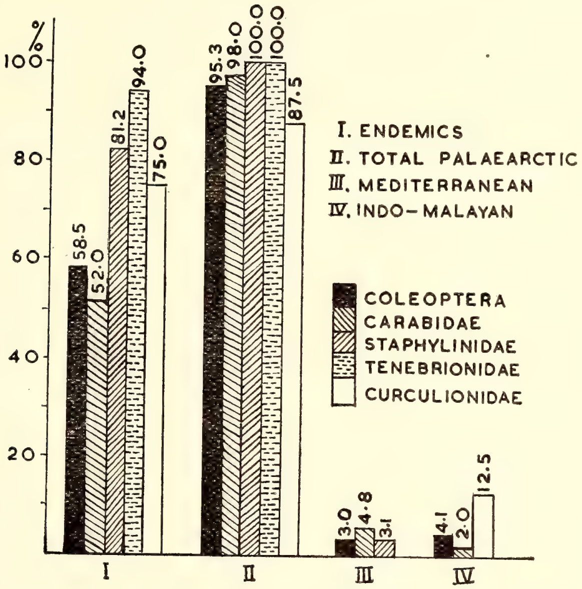


Fig. 13. The faunal elements of the nival Coleoptera from the north-west Himalaya.

Of the four endemic *Amara,* two species *ambigene* Bates (4267 m.) and *lamia* Andr. (3400-4664 m.) are also localized in the Indus drainage area. *Carabus* (*Imaibus*) *barysomus* (Bates), *Carabus* (*Imaibius*) *dardiellus granulisparus* Bates, *Carabus* (*Imaibius*) *epipleuralis* Sem., and *Carabus* (*Imaibus*) *rostianus* Sem. are localized near the timber line in the area drained by R. Jhelum on the Pir Panjal Range and south of the main crest line of the Great Himalaya. *Cymindis alticola* Gebl., *Cymindis babaulti* Andr., and *Cymindis glabrella* Bates, found near an elevation of 3200 m., and *Cymindis rubriceps* Andr. found at an elevation of 5151 m., are localized in the Indus drainage area. Also localized in the same area is *Nebria limbigera babaulti* Andr., occurring at an elevation of 4420 m. The typical form *Nebria limbigera* Solsky, found at elevations ranging from 4267 m. to 4541 m. in the Indus drainage area, is also known from Kumaon Himalaya, Pamir, Alai, Kokand, and China (Fig. 14). Outside the NW. Himalaya, we have the interesting record of the occurrence of the three subspecies *Nebria limbigera alaiensis* Glas. from Alai and Pamir, *Nebria limbigera picta* Sem., and *Nebria limbigera kandspstisa* Glas. from Pamir. Among the other endemic Carabidae, the monotypic *Chaetobroscus anomalus* (Chaud.), found between 3000 m. and 3657 m., is localized in the drainage area of R. Jhelum, south of the main crest line of the Great Himalaya. Also localized in the same area are *Phaeropsophus stenoderus* Chaud. (Indo-Malayan) and *Pristonychus kashmirensis babaulti* Andr. The typical form *Pristonychus kashmirensis* Bates, found between 3300 m. and 4267 m., is localized in the Indus drainage area.

Bembidion has a total of 27 species and is also characterized by maximum species endemism. It is essentially a Holarctic genus, with only one or two species found in the lowlands of India, but several species are known from Finnoscandinavia, Alaska, and the far North. The Holarctic *Trechus*, of which several species are known from Turkestan mountains, is represented by three species in the NW. Himalaya. *Trechus cameroni bistriatus* Jeann., an endemite, is localized in the Chenab-Beas drainage area, south of the main crest line of the Great Himalaya. The typical form is known from the Simla Hills of the Garhwal Himalaya. The distribution of the non-endemic species of *Trechus* is shown in Fig. 14. It is interesting to observe that the Palaearctic *Harpalus*, which with one exception is restricted to the Himalaya in India, is strictly localized in the drainage areas of Jhelum and Chenab-Beas and is mostly found below an elevation of 4300 m. The subgenus *Nebria* (*Patronebria*), with one species *himalayica* (Bates), is also known from Garhwal, Kumaon, Bhutan, Tibet, and Siberia. Among the non-endemites, *Cymindis mannerhemi* Gebl., occurring between 4267 m. and 4520 m. and localized in the Indus drainage area, is also known from Pamir and central Asia. *Amara brucei* Andr., found at an elevation of 5300 m. in the Indus drainage area, is also reported to occur at an elevation 5030 m. near the Mt. Everest area in E. Himalaya. *Amara darjilingensis* Putz., found at about an elevation of 3200 m., is also known from Kumaon, Sikkim, Darjeeling, and Khasi Hills. *Amara himalaica* Bates, which occurs above an elevation of 3300 m., is reported at lower elevations from Simla Hills and Kumaon Himalaya (Fig. 15). Of the non-endemic *Bembidion* (Fig. 15), five species viz. *braculatum* Bates, *gagates* Andr., *hasurda* Andr., *nivicola* Andr., and *pluto* Andr., occur in other parts of the Himalaya, E. of the R. Sutlej. *Bembidion bucephalum* Net. and *Bembidion dardum* Bates are known from Turkestan mountains, *Bembidion himalayanum* Andr. and *Bembidion pamiricola* Lut. from Pamir, and *Bembidion satanus* Andr. from Hindukush. *Bembidion fuscicrus* Motsch. is widely distributed in Pamir, central Asia, Siberia, and western parts of N. America (Fig. 16).

The Palaearctic element is high and amounts to nearly 95.0% of the nival species known at present. *Calosoma* represents the Mediterranean element. The subspecies *Calosoma maderae auropunctatum* (Herb.) is endemic but *Calosoma maderae indicum* Hope is also reported from the lowlands of India and Peshawar in Pakistan. *Calosoma maderae kashmirense* Breun. occurs in Tibet also. *Phaeropsophus catoirei* (Dej.), *Phaeropsophus cosularis* (Schm. & Boeb.), *Phaeropsophus stenoderus* Chaud., and *Scarites predator* Chaud. comprise the Indo-Malayan forms, which are found mostly near the timber line and do not seem to occur above an elevation of 3500 m. *Bradytus apricarius* (Payk.), found in the Indus drainage area, is also known to occur in Pamir, Canada, and the President Range in the Nearctic Realm. The distribution of the genus *Bradytus* is shown in Fig. 17.

Of the 7 species of Dytiscidae so far known in the nival zones of the NW. Himalaya, 4 species are endemites. Six of the species are localized in the Indus drainage area and often occur at elevations ranging from 4267 m. to 4527 m. *Potamonectes* (*Potamonectes*) *griseostriatus* Deg. (Fig. 18), found in many localities in the NW. Himalaya, is also known from Europe, Siberia, and N. America.

In the Hydrophilidae, the only endemite is *Helophorus* (*Meghelophorus*) *aquaticus* Linn., occurring between 4175 and 4300 m. *Atracthelophorus frater* d'Orch., occurring at an elevation of 4724 m., represents at present the highest altitude record in the family. The wide distribution of the remaining non-endemic forms in the Tibetan Palaearctic is shown in Fig. 19. d'Orchymont (29) has briefly discussed the peculiarities of the distribution of the high altitude Hydrophilidae of Tibet and Himalaya.

The family Staphylinidae, with 32 species, representing about 16% of the total nival Coleoptera, stands next to Carabidae in abundance. All the species are Palaearctic and the species endemism is about 81%. Of the 26 endemites, 19 belong to the genus *Atheta*, of which there are also 3 other non-endemic forms. The five species *Atheta* (*Acrotona*) *fungi kashmirensis* (Gr.), *Atheta* (*Aloconota*) *iguensis*

Cam., *Atheta* (*Bessobia*) *submetallica* Cam., *Atheta* (*Dimetrota*) *hutchinsoni* Cam., and *Atheta* (*Microdota*) *ladakiana* Cam. are mostly localized in the Indus drainage area and the remaining endemic species are localized in the Jhelum drainage area. The rest of the endemic species belong to the genera *Geodromicus, Lesteva, Ocyusa, Oxypoda, Philonthus, Pseudocyusa,* and *Tachinus.*

Among the non-endemic Staphylinidae, the distribution of the following species is interesting. *Aleochara* (*Coprochara*) *bilineata* Gyll., occurring at an elevation of 4870 m., is also known from Garhwal Himalaya, Caucasus, and Europe. *Atheta triangulum* (Kr.), a Mediterranean element, seems to be confined to elevations immediately above the timber line. Five species are found above an elevation of 4000 m. *Atheta* (*Dimetrota*) *hutchinsoni* Cam., found at an elevation of 5600 m., represents the highest altitude at which any Coleoptera is known at present from the world.

The family Tenebrionidae is remarkable for the highest degree of species endemism in Coleoptera, viz. 100%. There are also two endemic genera, viz. *Bioramix* and *Chianalus.* All the species are Palaearctic forms. Outside the NW. Himalaya, the genus *Ascelosodis* is known from Pamir only. *Syachis* is represented by one species from Turkestan mountains and one species from Afghanistan. *Cyphogenia* is widely distributed in the steppes of Asia from Mongolia and China to Caspian Sea and has about eight species in Iran and Afghanistan. *Prosodes* is also found in Iran, Afghanistan, Baluchistan, and SE. Europe. *Blaps* is known from Palaearctic and south Palaearctic of Asia, African Mediterranean, E. and central Europe. It is also interesting to note that all the species are localized in the Indus drainage area. Two species of *Blaps, Cyphogenia plana* Bates and *Myatis quadraticollis* Bates, occur above an elevation of 4000 m.

Species endemism in Curculionidae is 75% and the Palaearctic elements amount to nearly 87%. The genus *Catapionus* (Fig. 20) is known from Japan, Semirjetschensk, Siberia, Altai, Thian Shan, Kasghar, Karakorum, Turkestan mountains, Sikkim, Tibet, Kurlien Islands, and Amur. The genus *Scepticus* is distributed (Fig. 20) in Kasghar, Turkestan Mountains, Altai, Japan, Okinawa, Formosa, and does not extend west of Turkestan. In the NW. Himalaya it is widely distributed in the areas drained by R. Indus, R. Jhelum, and Chenab-Beas system, both N. and S. of the main crest line of the Great Himalaya. *Blosyrodes* represents the Indo-Malayan element. Among the non-endemic species, *Otiorrhynchus russicus* Stier. is known from Russia, and *Sitones calossus* Gyll. is known from central and S. Europe and central and W. Asia. Most of the species occur immediately above the timber line but four species, which are all endemic, occur at elevations above 4000 m.

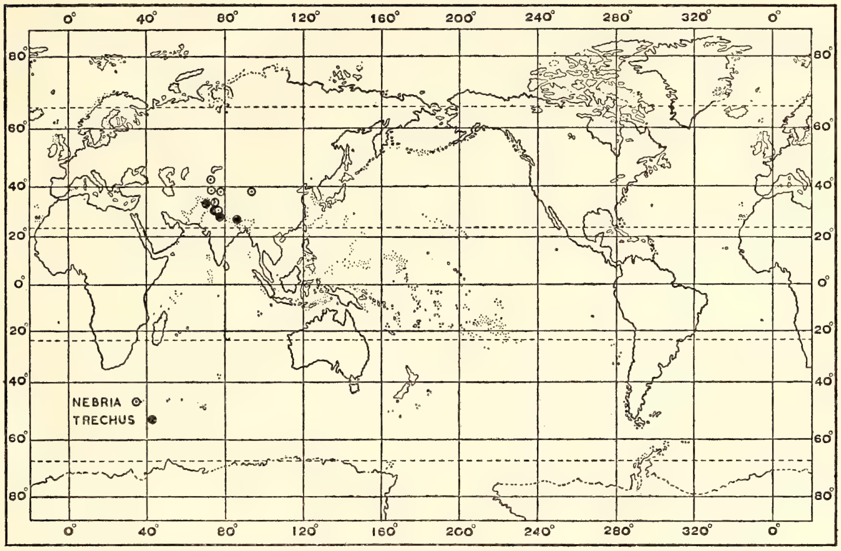

0° 40° 80° 120° 160° 200° 240° 280° 320° 0°
80° 60° 40° 20° 0° 20° 40° 60° 80°
NEBRIA ⊙
TRECHUS ●

Fig. 14. The world distribution of the non-endemic nival species of *Nebria* and *Trechus* from the north-west Himalaya.

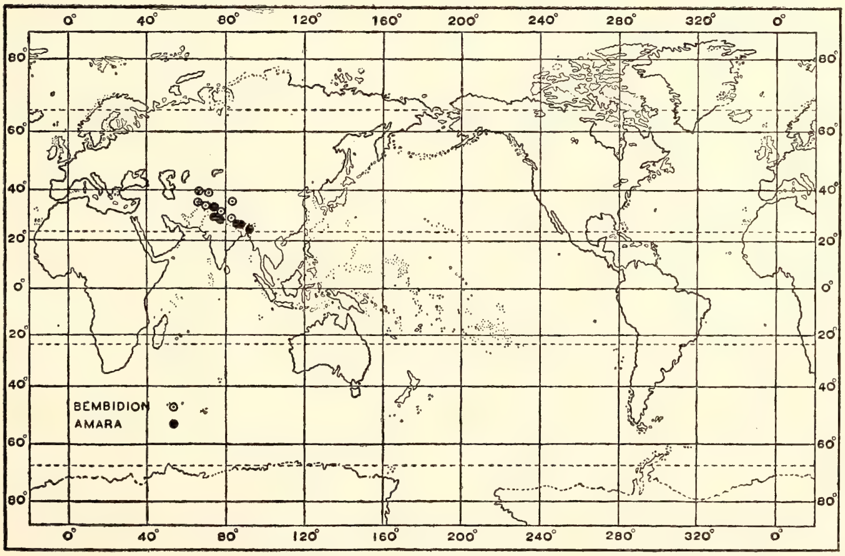
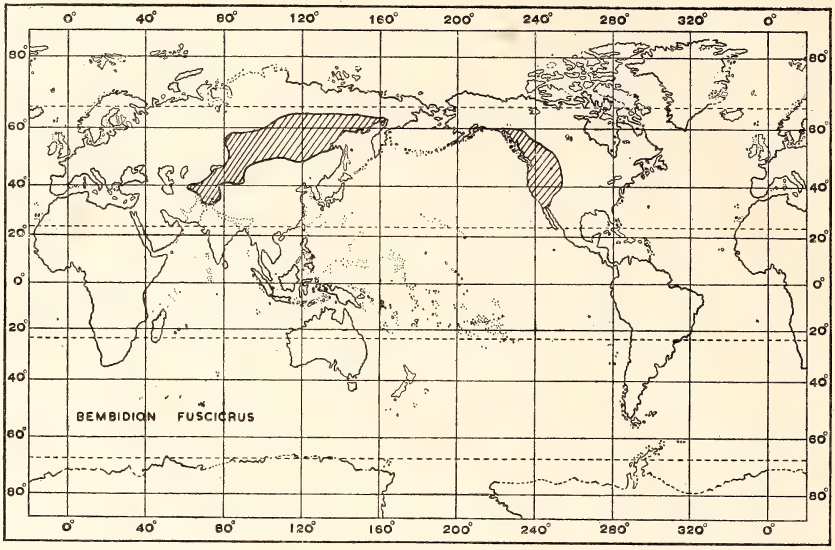

0° 40° 80° 120° 160° 200° 240° 280° 320° 0°
80° 60° 40° 20° 0° 20° 40° 60° 80°
BEMBIDION ⊙
AMARA ●

Fig. 15. The world distribution of the non-endemic species of *Amara* and *Bembidion* from the north-west Himalaya. The area of their endemism is confined to the Pamir-Tibet-north-west Himalaya region.


0°
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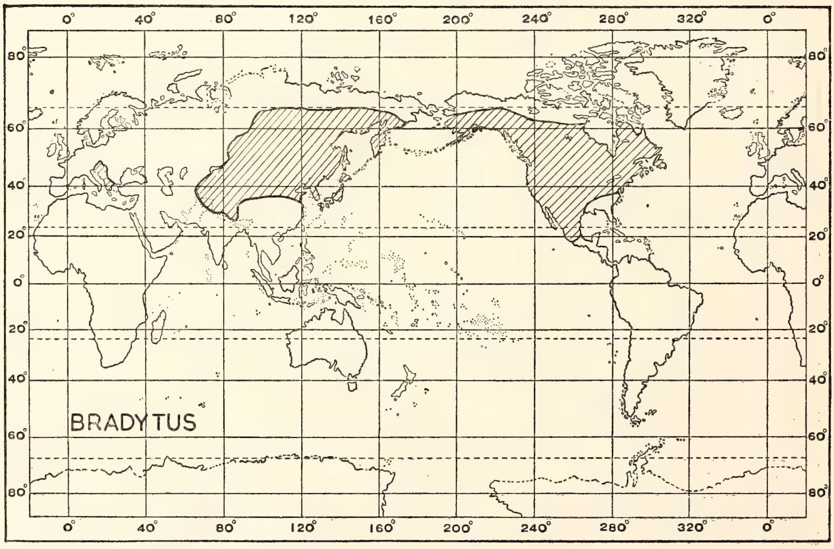
80°
120°
160°
200°
240°
280°
320°
0°
80°
60°
40°
20°
0°
20°
40°
60°
80°
BEMBIDION FUSCICRUS

Fig. 16. The area (striped) of the world distribution of the interesting Holarctic species *Bembidion fuscicrus* (Motschulsky).


0°
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80°
BRADYTUS

Fig. 17. The area (striped) of the world distribution of the genus *Bradytus*.

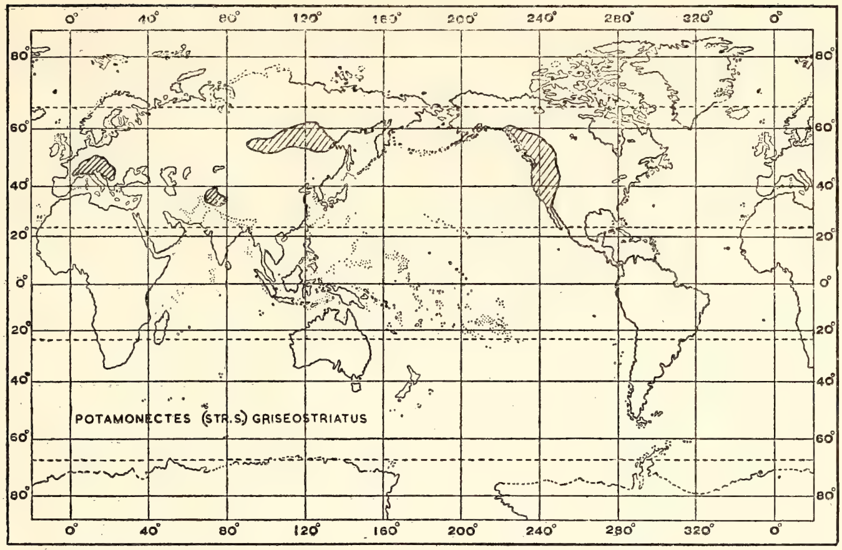
0° 40° 80° 120° 160° 200° 240° 280° 320° 0°
80° 60° 40° 20° 0° 20° 40° 60° 80°
POTAMONECTES (STR.S) GRISEOSTRIATUS

Fig. 18. The area (striped) of the world distribution of *Potamonectes* (*Potamonectes*) *griseostriatus* Deg.

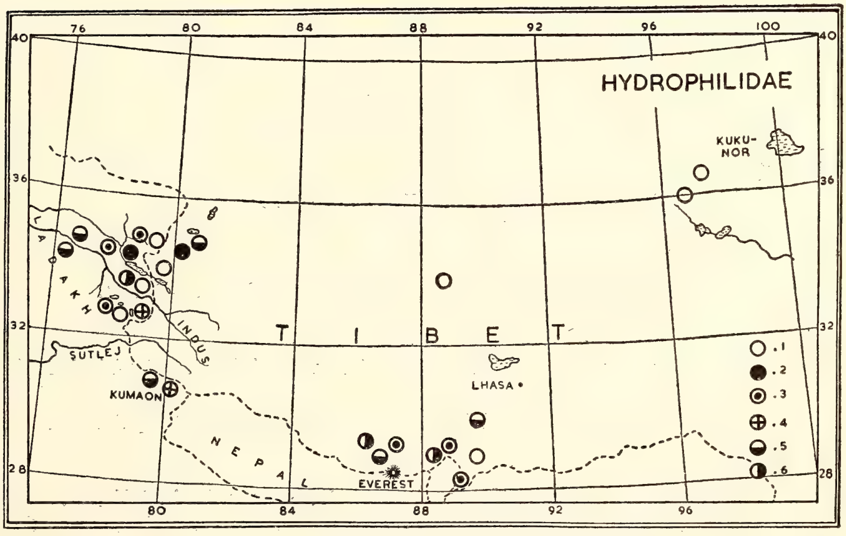
76 80 84 88 92 96 100
40 36 32 28
HYDROPHILIDAE
KUKU-NOR
LADAKH
INDUS
SUTLEJ
KUMAON
T I B E T
LHASA
NEPAL
EVEREST
○ .1
● .2
◉ .3
⊕ .4
⊖ .5
◐ .6
80 84 88 92 96

Fig. 19. The world distribution of the nival Hydrophilidae from the north-west Himalaya, modified from d'Orchymont (29). 1. *Helophorus* (*Lihelophorus*) *ser* Zait. 2. *Helophorus* (*Meghelophorus*) *aquaticus* Linn. 3. *Helophorus* (*Helophorus*) *splendidus immaensis* d'Orchymont. 4. *Helophorus* (*Atracthelophorus*) *frater* d'Orchymont. 5. *Helophorus* (*Atracthelophorus*) *montanus* d'Orchymont. 6. *Laccobius* (*Laccobius*) *hingstoni* d'Orchymont.

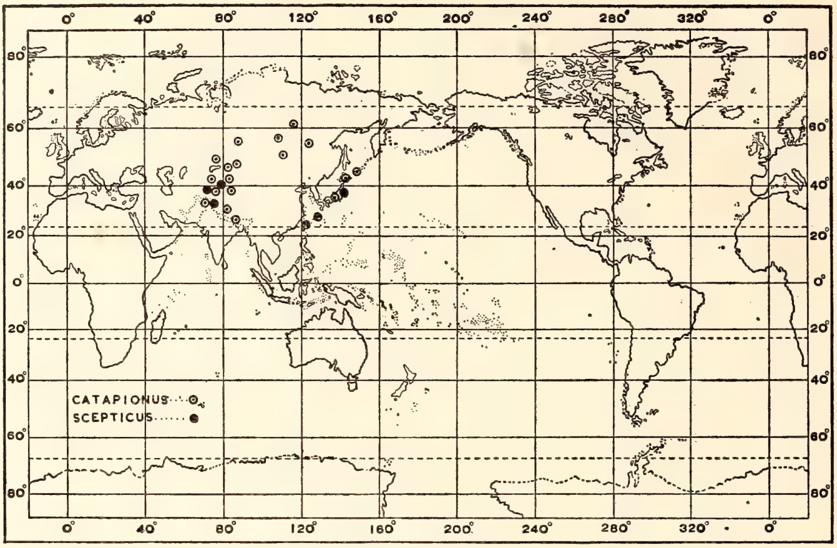

Fig. 20. The world distribution of the non-endemic nival species of *Catapionus* and *Scepticus* from the north-west Himalaya.

Cicindelidae

1. **Cicindela sublacerata balucha** Bates
Localities : Skardu 3000 m.
Other Distribution : Baluchistan.

Carabidae

2. **Agonum ladakense** Bates
Localities : Kashmir about 3000 m.
Other Distribution : Pamir ; Jalalabad; Tibet 3960 m.

*3. **Amara ambigene** Bates
Localities : Pangong Valley between Tanktze and Chagra, 4267 m.

4. **Amara brucei** Andr.
Localities : Ororotse Tso 5300 m., Anem La 5181 m., Tso-Nyak region 4350 m.
Other Localities : Second Mt. Everest Expedition Base Camp 5030 m.

5. **Amara darjilingensis** Putz.
Localities : Jalori Pass 3290 m., Dharmsala, Naggar, Parbati Valley.
Other Distribution : Kumaon, Sundardhunga Valley, Sukha Tal, Gori Valley, Bhurphu, Chuli Khad (Chakrata), Sikkim, Darjeeling, Lachung, Khasi Hills.

*6. **Amara depilatus** (Bates)
Localities : Goorais Valley, Skardu about 3000 m.

7. **Amara himalaica** Bates

Localities : Dras 3100 m., Kargil 2740 m., Leh 3437 m., Sumdeo 3300 m., Bashahr (Poo) 2800 m.
Other Distribution : Simla Hills, Kotgarh, Matiana, Almora, Ranikhet.

*8. **Amara lamia** Andr.

Localities : Leh 3440 m., Tso-Morari 4664 m.

9. **Amara nila** Andr.

Localities : Manikaran, Pulga, Tchary-Djoni, Tsho-ti 3200 m., Kulu, Kandy, Kote, Bajaura, Chamba.
Other Distribution : Mussoorie, Pindar Valley, Sundardhunga Valley, Konain, Chitri Khud.

*10. **Amara tiruka** Andr.

Localities : Sonemarg 3000 m., Leh 3440 m.

*11. **Amolops piliferus** (Bates)

Localities : Goorais Valley, Skardu 3000 m., Murree.

*12. **Anchomenus bernardi** Andr.

Localities : Gondhla 3200 m., Keylang 3300 m., Sisu 3300 m., Pulga, Tchary-Djoni, 3200 m., Manikaran, Kulu, Kote, Parbati Valley.

13. **Anchomenus ladakensis** Bates

Localities : Leh 3440 m., Kargil 2740 m., Pangong Valley between Tanktze and Chagra 4267 m.
Other Distribution : Tibet (Gyangtse) 3600 m.

14. **Anchomenus caesitius** Andr.

Localities : Sisu 3300 m., Sumdeo 3300 m., Kulu, Kandy, Kote.
Other Distribution : Almora.

*15. **Bembidion ajmonis** Net.

Localities : Razdhainangan 3500 m.

*16. **Bembidion algidum** Andr.

Localities : Gulmarg 2438-2743 m., Khilanmarg 3350 m.

*17. **Bembidion aquilum** Andr.

Localities : Patseo 3500 m., Gond, Baltal 3000 m., Leh 3440, Mulbek 4520 m., Skardu, Gulmarg 2800 m.

*18. **Bembidion atlanta** Andr.

Localities : Lianmarg 3050 m.

*19. **Bembidion beesoni** Andr.

Localities : Khilanmarg 3350 m., Razhainangan 3657 m.

20. **Bembidion braculatum** Bates

Localities : Skardu 3000 m., Matayan 3050 m.
Other Distribution : Kumaon, Gori River gorge, Laptel 4572 m., Milam in Gori Valley 3500 m.

21. **Bembidion bucephalum** Net.

Localities : Chhota Deosi 3962 m., Boorgi Nullah 3657 m., Braldo Valley, Kro Brok 3700 m., Thla Brok 4267 m., Punmah Valley, Dumiltar 4267 m., Baltora, Urdukas 4080 m., Mundu 3960-5000 m., Lopsang Bransa 4578 m. All Kashmir.

Other Distribution : Turkestan, Bukhara, Transcaspia.

*22. **Bembidion caporoaccoi** Net.

Localities : Sind Valley, Kangan 2000 m., Olthingthang 2618 m., Shigar Valley, Alchori, Kushumul all above 3000 m., Braldo Valley, Askole and Biaho 3050 m.

23. **Bembidion dardum** Bates

Localities : Goorais Valley, Skardu 3000 m.

Other Distribution : Bukhara.

24. **Bembidion fuscicrus** Motsch.

Localities : Baltal 3000 m., Leh 3440 m., Mulbek 4420 m., Nurla, Salt Lake 3627, Tso-Morari 4541, Nima Mud 4267 m., Pangur Tso 4437 m., Tso-Nyak 4470 m.

Other Distribution : Central Asia, Siberia, Western States of North America.

25. **Bembidion gagates** Andr.

Localities : Gond 3050 m., Manikaran, Pulga, Keylang 3220 m., Patseo 3300 m., Sumdeo 3300 m., Kulu, Kote, Kangra.

Other Distribution : Upto eastern Kumaon.

26. **Bembidion hasurada** Andr.

Localities : Gulmarg 2800 m., Apharwat 4260, Kangan, Mulbek 4420 m., Pulga, Batote, Raman, Kulu.

Other Distribution : Simla Hills, West Almora, Chakrata.

27. **Bembidion himalayanum** Andr.

Localities : Patseo 3300 m., Kangra, Baijnath, Dharmsala, Triund, Jalori Pass 3280 m.

Other Distribution : Kurram Valley, Tibet.

*28. **Bembidion hutchinsoni** Andr.

Localities : Kyam 4734 m. (Edge of hot spring).

*29. **Bembidion irregularae** Net.

Localities : Gond 2440 m., Shaksgan Valley 3962 m., Tarim Basin 4572 m.

*30. **Bembidion ixion** Andr.

Localities : Matayan 3050 m.

*31. **Bembidion ladakense** Andr.

Localities : Mulbek 4420 m., Gond 3000 m., Baltal 3000 m., Sumdeo 3300 m., Khalatse 4572 m., Biaho Valley, Bardumul 3362 m.

*32. **Bembidion ladas** Andr.

Localities : Nima Mud 4267 m., Tso-Morari 4541 m., Salt Lake 3627 m., Leh 3440 m., Mulbek 4420 m., Rango.

*33. **Bembidion leve** Andr.

Localities : Mulbek 4420 m.

*34. **Bembidion livens** Andr.

Localities : Khalatse 3048-3657 m.

*35. **Bembidion luntaka** Andr.

Localities : Suru Basin 3050 m., Shimtsa 3200 m., Karboo, Parkutta, Tolti, Golskardu, Leh 3440 m., Mulbek 4520 m., Nurla, Baltal 3000 m., Sonemarg 3000 m., Nima Mud 4267 m., Keylang 3300 m., Sisu 3300 m., Zingzingbar 4267 m., Olthingthang 3140 m., Shigar Valley, Juno, Alchori, Kushumul 2440 m.

36. **Bembidion nivicola** Andr.

Localities : Daulad Begaldi near Karakoram Pass 4730 m.
Other Distribution : Mt. Everest Base Camp 4730 m.

37. **Bembidion pamiricola** Lutchnik.

Localities : Biaho Valley, Bardumul 3352 m.
Other Distribution : Pamir.

38. **Bembidion petrimagni** Net.

Localities : Deosi, Lal Pani 3962 m., Baltoro 4000-4800 m., Widukas 4327 m.
Other Distribution : Pamir.

*39. **Bembidion pictum** (Fald.).

Localities : Leh 3440 m., Mulbek 4420 m., Nurla, Baltal 3000 m., Lac Sale 3627 m., Tso-Morari 4541 m., Nima Mud 4267 m.

40. **Bembidion pluto** Andr.

Localities : Nima Mud 4267 m., Tso-Morari 4541 m., Salt Lake 3627 m., Leh 3440 m., Tangyar 4430 m., Lukung 4267 m., Igu 3637 m.
Other Distribution : Kumaon.

41. **Bembidion satanas** Andr.

Localities : Goorais Valley 2133 m., Gulmarg 2590 m., Liddar Valley 2743 m., Gond, Kolahoi 3360 m.
Other Distribution : Chitral.

42. **Bradytus apricarius** (Payk.)

Localities : Sind Valley, Sonemarg 3000 m., Dras 3100 m., Kargil 2740 m., Leh 3440 m.
Other Distribution : Between Sirikol and Panga, Canada, President Range (America).

*43. **Calathus kollari** Putz.

Localities : Sumdeo 3400 m., Pulga, Manikaran, Tchary-Djoni 3200 m., Bajaura, Kulu, Kote, Kandy, Baltal 3000 m.

*44. **Calosoma maderae auropunctatum** (Herb.)

Localities : Kulu, Sumdeo 3400 m., Patseo 3300 m., Keylang 3200 m., Cimur 3300 m., Rohtang Valley 3900 m., Chamba, Sonemarg, Kogyar, Sind Valley, Dras 3100 m., Kargil 2740 m., Leh 3440 m.

45. **Calosoma maderae indicum** Hope

Localities : Pulga, Tho-ti 3200 m., Manikaran, Gond, Srinagar.
Other Distribution : Peshawar, Taru, Kohat, Calcutta, Pusa (Bihar), Chapra, Dehra Dun.

46. **Calosoma maderae kashmirense** Breun.

Localities : Kashmir, Kulu, Rohtang Valley 3900 m., Sumdeo 3300 m.
Other Distribution : Tibet 4000 m.

47. **Clivinia tenuelimbatus** Ball.

Localities : Goorais Valley, Leh 3440 m.
Other Distribution : Turkestan.

*48. **Carabus (Imaibius) barysomus** (Bates)

Localities : Goorais Valley, Pir Panjal, Batote 2440-3050 m., Hazara, Lower Kagan Valley, Shran.

49. **Carabus (Imaibius) boysi** Tatum.

Localities : Sonemarg 3000 m., Kulu, Kani, Chamba, Pulga, Tchary-Djoni 3200 m., Tsho-ti 3200 m.
Other Distribution : Simla, Garhwal, Mundali, Deoban, Bodyar, West Almora, Dhudatoli and Sundardhunga Valley.

*50. **Carabus (Imaibius) dardiellus granulisparsus** Bates.

Localities : Goorais Valley, Pir Panjal south of Srinagar 2440-3050 m., Jhelum Valley, Gulmarg 2750 m.

*51. **Carabus (Imaibius) epipleuralis** Sem.

Localities : Mountains west of Pir Panjal and north of Poonch 3000-3500 m.

*52. **Carabus (Imaibius) rostianus** Sem.

Localities : North-east of Islamabad 1828 m., Songam Dusu, south-east of Islamabad 1828-3050 m., Liddar Valley, Tanin 2750 m.

53. **Carabus (Imaibius) stoliczkanus** Bates

Localities : Mountains west of Pir Panjal 1820-3050 m., Murree.
Other Distribution : Campbellpore.

*54. **Chaetobroscus anomalus** (Chaud.)

Localities : Sisu 3200 m., Rohtang Valley 3900 m., Shishramnag 3657 m., Khilanmarg 3050 m., Lidarwat 2750 m., Jalori Pass 3300 m., Tragbal Pass 3300 m., Chamba, Dalhousie.

55. **Chlaenius caeruleus** (Stev.)

Localities : Mulbek 4420 m., Goorais Valley, Srinagar, Seraj.
Other Distribution : Baluchistan, Armenia, S. Russia.

*56. **Chlaenius tenuelimbatus** Ball.

Localities : Leh 3440 m.

*57. **Cymindis altica** Gebl.

Localities : Between Dras and Leh 3100-3440 m.

*58. **Cymindis babaulti** Andr.

Localities : Leh 3440 m.

59. **Cymindis championi** Andr.
Localities : Tso-Nyak 4357 m.
Other Distribution : Northern Kumaon, Tibet.

*60. **Cymindis glabrella** Bates
Localities : Baltal 3000 m., Ladakh 3200 m.

61. **Cymindis mannerheimi** Gebl.
Localities : Baltal 3000 m., Mulbek 4520 m., Pangong Valley 4267 m., Tangyar 4470 m.
Other Distribution : Pamir, Tarabagtai Mountains, Issyk-kul, all central Asia.

*62. **Cymindis rubriceps** Andr.
Localities : Anem La 5181 m.

*63. **Dyschirius ladakensis** Andr.
Localities : Ladakh 3500 m.

*64. **Harpalus amarellus** Bates
Localities : Kangra, Bajaura, Mandi, Naggar, Cimur 3300 m., Keylang 3200 m., Sumdeo 3300 m., Sisu 3200 m.

65. **Harpalus melaneus** Bates
Localities : Baltal 3000 m., Sonemarg, Rohtang Valley 3900 m., Kote, Pulga, Sumdeo 3300 m., Zingzingbar 4267 m., Patseo 3770, Sisu 3200 m., Keylang 3300 m. Gondhla 3200 m., Cimur 3300 m., Chamba, Murree, Dalhousie.
Other Distribution : Mundali, Dehra Dun, Almora.

66. **Harpalus quadricollis** (Redt.)
Localities : Sisu 3200 m., Zingzingbar 4267 m., Patseo 3770 m., Sumdeo 3300 m., Keylang 3300 m., Pulga, Baltal.
Other Distribution : Rawalpindi, Kumaon.

67. **Hypsinephus ellipticus** Bates
Localities : Baltal 3000 m., Pangong Valley 4267 m.
Other Distribution : Supi River (Tibet).

*68. **Leistus nivium** Andr.
Localities : Dusu, Sintan Pass 3000 m.

69. **Liocnemis himalaica** Bates
Localities : Sumdeo 3200 m., Sonemarg 3000 m.
Other Distribution : W. Almora.

*70. **Metabletus tartarus** Bates
Localities : Patseo 3770 m., Sind Valley.

71. **Nebria limbigera** Solsky
Localities : Tso-Morari 4541 m., Nima Mud 4267 m., Zingzingbar 4267 m., Mulbek 4420 m., Kargil 2740 m.
Other Distribution : Kumaon, Turkestan, Kokand, Alai Mountains, Pamir, China : Monpin.

*72. **Nebria limbigera babaulti** Andr.

Localities : Baltal 3000 m., Mulbek 4420 m.

73. **Nebria (Patronebria) himalayica** (Bates)

Localities : Goorais Valley, Skardu 3000 m., Parbati Valley, Bashahr (Poo).
Other Distribution : Almora, Milam in Gori Valley, 3500 m., Khedar Khud (Chakrata Division).

*74. **Pardileus indicus** (Bates)

Localities : Pulga, Tsho-ti, Tchary-Djoni 3200 m., Bajaura, Kulu, Kandi, Kangra.

75. **Phaeropsophus catoirei** (Dej.)

Localities : Bajaura, Kulu, Naggar, Mandi, Gharry, Baltal 3000 m.
Other Distribution : Ceylon, Burma, Andaman Island.

76. **Phaeropsophus consularis** (Schm. & Boeb.)

Localities: Gharry 3000 m., Kangra.
Other Distribution : Dehra Dun, Ranikhet, Chhota Nagpur, Konbir, Chapra, Sardah, Dacca, Assam, Silonibari, Sibsagar, Siliguri, Surada, Karen Hills, Bhamo.

*77. **Phaeropsophus stenoderus** Chaud.

Localities : Gharry 3000 m., Bajaura.

78. **Pristonychus kashmirensis** Bates

Localities: Goorais Valley, Liddar Valley, Khilanmarg 4000 m., Gulmarg 2750 m., Sintan, Pir Panjal, Upper Mundag, Kulu.
Other Distribution: Simla.

*79. **Pristonychus kashmirensis babaulti** Andr.

Localities : Tsho-ti, Tchary-Djoni 3200 m., Pulga, Sisu 3200 m., Gondhla 3200 m., Keylang 3300 m., Sumdeo 3300 m. Rohtang Valley 3900 m., Kote, Kandy, Sonemarg 3000 m.

80. **Scarites praedator** Chaud.

Localities : Gharry, Baltal 3000 m., Sonemarg 3000 m.
Other Distribution: Sikkim, Assam, Bangla, Bihar, Orissa, Punjab, Bombay, Kodaikanal, Nilumbur, Burma, Rangoon.

81. **Tachys octostriatus** Net.

Localities : Sind Valley, Kangan, Suru Basin 3000 m., Kargil 2740 m.
Other Distribution : Sangla 2440 m., (east of Sutlej Valley in Bashahr).

82. **Trechus cameroni** Jeann.

Localities : Rohtang Pass 4150 m., Jalori Pass 3280 m.
Other Distribution : Simla Hills ; Narkanda 2800 m., Throch 3050 m.

*83. **Trechus cameroni bistriatus** Jeann.

Localities : Kareri Lake 3050 m.

84. **Trechus indicus championi** Jeann.

Localities : Pulga, Cimur 3300 m., Baltal 3000 m., Sonemarg 3000 m., Dharamsala, Mandi.

Other Distribution : Simla, Darjeeling, Gopalda, Ranikhet, Nainital, Almora, Sikkim, Gumti Valley.

*85. **Trichocellus roborowskii** Tchitch.
Localities : Baltal 3000 m., Leh 3440 m., Lac Sale, Nima Mud 4267 m.

Dytiscidae

86. **Dytiscus nitidus** Fab.
Localities : Dras 3100 m., Kargil 2740 m., Leh 3440 m.
Other Distribution : Central Europe.

*87. **Coelambus flaviventris** Motsch.
Localities : Thongmon Tso above 4000 m.

88. **Potamonectes (Potamonectes) griseostriatus** Deg.
Localities : Kashmir, Ladakh, Digar Polu 3960 m., Kangral, Spring below Fotu La, Chushul 4340 m., Tso Kar 4527 m., Ghulam Bagh, Pangong Valley.
Other Distribution : East Europe, Siberia, N. America.

*89. **Agabus (Anagabus) jucundus** Guignot
Localities : Kargil about 3000 m.

*90. **Agabus (Dichonectes) nitidus** F.
Localities : Sonemarg 3000 m., Dras 3100 m., Kargil 2740 m., Nima 4267 m., Digar Polu 3960 m., Bao-Shaple 4570 m.

*91. **Agabus (Gaurodytes) adustus** Guignot
Localities : Chushul 4336 m.

92. **Rahntus pulverosus** Steph.
Localities : Ladakh, Sonemarg 3000 m., Kangan, Ghulam Bagh, Srinagar.
Other Distribution : Europe, North Africa, Asia, Australia, Sunda Isles.

Hydrophilidae

93. **Helophorus (Atracthelophorus) frater** d'Orch.
Localities : Kashmir, Tso-Morari 4541 m.
Other Distribution : Laptel, 4572 m., border of Tibet and Kumaon, Sangchar 4724 m.

94. **Helophorus (Helophorus) splendidus immaensis** d'Orch.
Localities : Bai 4616 m., Kyam (Valley of R. Chang Chenmo) 4725 m., Sta-rtsk-puk-Tso (Tso Bar) 4538 m.
Other Distribution : Central Tibet : Phar, Kampe, Dshong 4420 m., Lingka 4420 m., Tingri 4572 m.

95. **Helophorus (Atracthelophorus) montanus** d'Orch.
Localities : Fotu La 3720 m.
Other Distribution : Western Tibet : Sulphur spring of Lake Mangzka 5400 m., central Tibet : Tingri 4572 m., Lingka and Shekkar 4420 m., Gyangtse 3962 m., Tibet-Kumaon-Border Laptel 4572 m., outside Tibet also from Aulie Ata on Syr-Daya.

96. **Helophorus (Lihelophorus) ser** Zaitzera

Localities: Kyam in Chang Chenmo Valley 4725 m., Chushul south of Pongong Tso 4300 m.

Other Distribution: Western Tibet: 50 kilometres east of Pongong Tso. Central Tibet: 4863 m., Eastern Tibet: The region of Kuku-Nor, Mang Tso 4429 m.

*97. **Helophorus (Meghelophorus) aquaticus** Linn.

Localities: East of Mugleb and between Mugleb and Tanktze 4175 m., north of Pongong Tso.

98. **Hydrous pallidipalpus** M'Leay

Localities: Kashmir 3000 m.

Other Distribution: Tibet 3900 m., Burma, China, Japan, Formosa, Sumatra and Java.

99. **Laccobius (Laccobius) hingstoni** d'Orch.

Localities: Chushul south of Pongong Tso 4336 m.

Other Distribution: C. Tibet: Kampa, Dshong 3200 m., Tingri 4572 m.

Histeridae

*100. **Hister indicola** Desb.

Localities: Pulga, Kulu, Kandi, Keylang 3300 m., Sumdeo 3300, m., Sisu 3200 m.

101. **Hister pullatus** Erich.

Localities: Manikaran, Gharry about 3000 m.

Other Distribution: Badia, Bilaspur, Dahora.

Staphylinidae

102. **Aleochara (Coprochara) bilineata** Gyll.

Localities: Tsak Shang above Tso-Morari 4870 m.

Other Distribution: Chakrata, Dehra Dun, Simla Hills, Europe, Caucasus.

103. **Aleochara (Mesochara) inornata** Cam.

Localities: Jalori Pass 3300 m.

Other Distribution: Chakrata, Deoban, Dehra Dun, Kumaon, Nainital, West Bhalkot.

*104. **Atheta (Acrotona) fungi kashmirensis** (Gr).

Localities: Askole (Braldo Valley) 3100 m., Shimtsa (Punmah) 3200 m.

*105. **Atheta (Acrotona) inequinata** Cam.

Localities: Gulmarg 3050 m.

*106. **Atheta (Aloconota) iguensis** Cam.

Localities: Igu 3380 m.

*107. **Atheta (Aloconota) morosa** Cam.

Localities: Gulmarg 3050 m.

*108. **Atheta (Bessobia) submetallica** Cam.
Localities : Tsak-Shang 4870 m.

*109. **Atheta (Datomicra) sordiduloides** Cam.
Localities : Gulmarg 3050 m.

*110. **Atheta (Datomicra) subarenicola** Cam.
Localities : Gulmarg 3050 m.

111. **Atheta (Dimetrota) adjacens** Cam.
Localities : Gulmarg 3050 m.
Other Distribution : Kotgarh, Narkanda.

*112. **Atheta (Dimetrota) associata** Cam.
Localities : Gulmarg 3050 m.

*113. **Atheta (Dimetrota) hutchinsoni** Cam.
Localities : Marsimik La 5600 m., Ororotse 5300 m.

*114. **Atheta (Dimetrota) nigrans** Cam.
Localities : Gulmarg 3050 m.

*115. **Atheta (Dimetrota) suballocera** Cam.
Localities : Gulmarg 3050 m.

116. **Atheta (Liogluta) subumbonata** Cam.
Localities : Gulmarg 3050 m.
Other Distribution : Chakrata, Deoban 2800 m.

*117. **Atheta (Microdota) amiculoides** Cam.
Localities : Gulmarg 3050 m.

*118. **Atheta (Microdota) gracillima** Cam.
Localities : Gulmarg 3050 m.

*119. **Atheta (Microdota) ladakiana** Cam.
Localities : Tsak-Shang, above Tso-Morari 4870 m.

*120. **Atheta (Microdota) subluctuosa** Cam.
Localities : Gulmarg 3050 m.

*121. **Atheta (Oreostibia) nimbicola** Cam.
Localities : Apharwat 3960 m., Gulmarg 2743 m.

*122. **Atheta nigrolucens** Cam.
Localities : Gulmarg 3050 m.

*123. **Atheta (Paraloconota) jaloriensis** Cam.
Localities : Jalori Pass 3280 m., Bhabu Pass 2743 m.

*124. **Atheta (Paraloconota) musicola** Cam.
Localities : Gulmarg 2433 m., Khilanmarg 3050 m., Kulu, Naggar.

125. **Atheta triangulum** (Kr.)
Localities : Gulmarg 2433-3050 m.
Other Distribution : Simla Hills, Gahan, Europe, Asia Minor.

*126. **Geodromicus affinis** Cam.
Localities : Kargil about 3000 m.

*127. **Lesteva kargilensis** Cam.
Localities : Kargil about 3000 m.

*128. **Ocyusa (Cousya) quadrisulcata** Bernh.
Localities : Baltora, Mondu 4300 m., Urdukas 4000 m., Lopsang Bransa 4500 m., Liligo 3800 m., Biaho-tal, Paju 3400 m.

129. **Oxypoda (Podoxya) nigrita** Cam.
Localities : Jalori Pass 3280 m., Jibhi, Seraj 1828 m., Gulmarg.
Other Distribution : Kumaon, Chakrata, Simla Hills.

*130. **Philonthus diversus** Schub.
Localities : Sintan, Shishram Nag, Liddar Valley 3657 m.

*131. **Philonthus himalayicus** Bernh.
Localities : Kulu 3050 m.

*132. **Pseudocyusa kashmirica** Cam.
Localities : Gulmarg, Khilanmarg 3050 m.

*133. **Tachinus beesoni** Cam.
Localities : Khilanmarg 3352 m.

Cantharidae

134. **Cantharis biocellata** Fair.
Localities : Karakoram 4000 m.
Other Distribution : Tibet 3900 m., North India, Hindukush.

Meloidae

135. **Mylabris phalerata** (Pall.)
Localities : Lakka Pass 3657 m., Dharmsala, Dalhousie, Kulti Nal 3657 m.
Other Distribution : Throughout India.

Elateridae

136. **Comsolacon aequalis** Cand.
Localities : Kashmir 3352 m.
Other Distribution : Wama (Afghanistan).

Coccinellidae

137. **Coccinella septempunctata** Linn.
Localities : Throughout Himalaya up to 4270 m.
Other Distribution : India, Europe.

138. **Thea bisoctonata** Muls.
Localities : Dhaula Dhar 4270 m.
Other Distribution : Indian plains, Egypt, Eritrea, Arabia, Palestine, Cape Verde Isles.

Tenebrionidae

*139. **Ascelosodis assimilis** Bates
Localities : Dras 3100 m., Kargil 2740 m., Leh 3440 m.

*140. **Ascelosodis ciliatus** Bates
Localities : Dras, Kargil, Leh, 3000-3450 m.

*141. **Ascelosodis grandis** Bates
Localities : Dras, Kargil, Leh, 3000-3450 m.

*142. **Ascelosodis intermedius** Bates
Localities : Dras, Kargil, Leh, 3000-3450 m.

*143. **Bioramix ovalis** Bates
Localities : Dras, Kargil, Leh, 3000-3450 m.

*144. **Bioramix puncticeps** Bates
Localities : Dras, Kargil, Leh, 3000-3450 m.

*145. **Blaps ladakensis** Bates
Localities : Tangtze to Chagra, Pangong Valley 4267 m.

*146. **Blaps perlonga** Bates
Localities : Tangtze to Chagra, Pangong Valley 4267 m.

*147. **Chianalus costipennis** Bates
Localities : Dras, Kargil, Leh, 3000-3450 m.

*148. **Cyphogenia plana** Bates
Localities : Dras, Kargil, Leh 3000-3450 m., Pangong Valley 4267 m.

149. **Myatis quadriticollis** Bates
Localities : Between Leh and Yarkand.
Other Distribution : Yarkand.

*150. **Opatrum ochthebiodes** Fauvel
Localities : Dras, Kargil, Leh, 3000-3450 m.

*151. **Prosodes trisulcata** Bates
Localities : Dras, Kargil, Leh 3000-3450 m.

*152. **Syachis ajmonis** Bates
Localities : High valleys of Kashmir, Dras, Kargil, Leh, 3000-3450 m.

*153. **Syachis cugiae** Gridelli
Localities : High valleys of Kashmir, 3000-3450 m.

*154. **Syachis himalaicus** Bates

Localities : Dras, Kargil, Leh 3000-3450 m.

*155. **Syachis picicornis** Bates

Localities : Dras, Kargil, Leh 3000-3450 m.

Scarabaeidae

156. **Onthophagus gibbosus** (Scriba)

Localities : River Sutlej, Tibet-Indian frontier, 3050 m.
Other Distribution : Turkestan, Persia, Asia Minor, Europe.

157. **Onthophagus sutlejensis** Splich.

Localities : Rajpur, Rampur, River Sutlej, Indian-Tibet frontier 3050 m., Bashahr.
Other Distribution : Wama, Nuristan (Afghanistan).

158. **Onthophagus tibetanus** Arrow

Localities : Khilanmarg 3050 m.
Other Distribution : Chaksam (Tibet) 3657 m., Brahmaputra Valley, Gyangtse 3962 m., U.P. : Dhauliganga Valley, Almora 3220 m.

Geotrupidae

*159. **Geotrupes kashmirensis** Sharp

Localities : Dras, Kargil, Leh 3000-3450 m.

Aphodidae

*160. **Aphodius kashmirensis** Sharp

Localities : Dras, Kargil, Leh 3000-3450 m.

Rutelidae

*161. **Adoretus ladakensis** Ohaus.

Localities : Ladakh 3450 m., Murree.

162. **Callistopopillia iris** (Cand.)

Localities : Ladakh 3450 m.
Other Distribution : Tibet, Yatong 3200 m., Sikkim, Kurseong, Mungphu.

Cerambycidae

163. **Apatophysis kashmiriana** Sem.

Localities : Kashmir about 3000 m.
Other Distribution : Punjab, W. Tibet 3900 m.

164. **Clytus monticola** Gahan

Localities : Kashmir about 3000 m.
Other Distribution : W. Tibet 3900 m.

*165. **Leptura rubriola** Bates

Localities : Murree, Gulberg, Liddar 3350 m.

166. **Purpuricenus montanus** White

Localities: West Kashmir about 3000 m.
Other Distribution : Campbellpore, W. Tibet 3900 m., outer Himalaya.

Chrysomelidae

167. **Galeruca sexcostata** Jacoby

Localities : Liddar 3350 m., Srinagar, Burzil Chauki 3350 m.
Other Distribution : Lahore.

*168. **Leptosonyx octocostatus** Weise

Localities : Khalatse 4572 m.

169. **Longitarsus cyanipennis** Bryant

Localities : Lahaul 3200 m.
Other Distribution : Kumaon, Surju Valley, Almora 2743 m., Nainital, Darjeeling, Gopaldhara.

170. **Merista quadrifasciata** (Hope)

Localities : Ladakh 3450 m., Kashmir, Kangra Valley 1370 m., Abbotabad, Murree.
Other Distribution : Bhimtal 4500 m., Almora 1670 m., Nainital, Simla, Ranikhet, Muktesar, Jeolikot, Mussoorie, Dehra Dun, Nepal: Gowchar, Gopaldhara, Pharping, Mungphu, Rungbong Valley.

Curculionidae

*171. **Achlaenomus babaulti** Hustache

Localities : Leh 3450 m., frontier of Tibet, Lac Sale 3657 m., Tso-Morari 4541 m.

*172. **Achlaenomus squamulosus** Hustache

Localities : Patseo 3400 m., Zingzingbar 4267 m., Sisu 3200 m., Rohtang Valley 3900 m., Kote, Kashmir.

173. **Blosyrodes pubescens** Marshall

Localities : Sisu 3200 m., Rohtang Valley 3900 m., Kashmir: Jarji 3410 m., towards Gilgit.
Other Distribution : Baluchistan.

174. **Blosyrodes variegatus** (Redt.)

Localities : Kashmir, Kangra, Bajaura, Tchary-Djoni 3200 m., Pulga, Gond.
Other Distribution : Mussoorie.

*175. **Calmycterus distans** (Faust.)

Localities : Tchary-Djoni 3200 m., Pulga.

*176. **Catapionus basilicus** Schnoh.

Localities : Koty, Gilgit, Tchary-Djoni, 3200 m.

*177. **Heteronyx ferus** Faust.

Localities : Tchary-Djoni, Tsho-Ti 3200 m., Pulga.

*178. **Heteronyx ferus loevior** Hustache

Localities : Sisu 3200 m., Rohtang Valley 3900 m.

*179. **Legenolobus lineolatus** Hustache

Localities : Leh 3450 m., Nima Mud 4267 m., Tso-Morari 4541 m., Lac Sale 3627 m., Tibet Frontier.

*180. **Leptomias marshalli** Hustache

Localities : Gondhla 3200 m., Keylang 3300 m., Sumdeo 3300 m.

*181. **Leptomias scribicollis** Marshall

Localities : Kashmir, Tchary-Djoni 3200 m., Pulga.

*182. **Otiorrhynchus russicus** Stierill.

Localities : Kashmir about 3000 m.

Other Distribution : Sirikol, Russia : Tchaar-Tasch.

*183. **Rhyncolus himalayensis** Stebb.

Localities : Tchary-Djoni 3200 m., Manikaran, Bajaura.

*184. **Scepticus nubifer** Faust.

Localities : Kargil 2740 m., Dras 3100 m., Leh 3450 m., Sisu 3200 m., Keylang 3300 m., Pateseo 3400 m., Sumdeo 3300 m., Zingzingbar 4267 m., Baltal 3000 m., Sonemarg, Gond, Rupshu, Tso-Morari 4541 m.

*185. **Sitones vergicolor** Faust.

Localities : Keylang 3300 m., Sumdeo 3300 m.

*186. **Sitones callosus** Gyll.

Localities : Gondhla 3200 m.

Other Distribution : Central, South-West Europe, Mediterranean Region, West and central Asia.

(To be continued)

Flora of District Muzaffarnagar in the Doab of the Rivers Ganga and Yumna

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(*With a map*)

PHYSICAL FEATURES AND TOPOGRAPHY OF THE AREA

Muzaffarnagar district, situated in the Indo-Gangetic plain in Uttar Pradesh, is bounded by the districts of Saharanpur in the north and Meerut in the south. On the west the River Yumna separates it from Panipat and Thaneshar tehsils of Karnal district (in East Punjab), while on the east the River Ganga separates it from Bijnor district. The main stream of the Ganga flows about 18 miles from the town, touching the boundary of the district at Sukhartal. The doab between these two rivers is served by a network of tributaries of the Ganga, namely the Kalinadi, the Budhiganga, the Solani, and the east Ganga canal.

The area is a plain consisting of recent alluvial deposits with kankar intercalations underneath, and at most places the topmost ‘ kankar pan ’ is within 6 ft. (2 m.) of the ground level. The top soil is variable, from sandy to sandy loam and clay.

Erosion along the banks of the Ganga and the Yumna is common. During the monsoons, water collecting and running scores out small gullies. As the ravines unite the intensity of soil erosion increases and, with the increase in the volume of running water, the ravines are dug deeper and wider.

Excessive grazing, heavy human population, and the local agricultural practices, all contribute to the erosion. Low-lying areas, either arising naturally as depressions, eroded gullies, stream beds, and oxbows, or artificially dug pools, puddles, and tanks form a conspicuous aspect of the landscape.

CLIMATE

The climate is dry monsoonic ; 760-1015 mm. of the precipitation falls during July to September. The mean annual temperature is about

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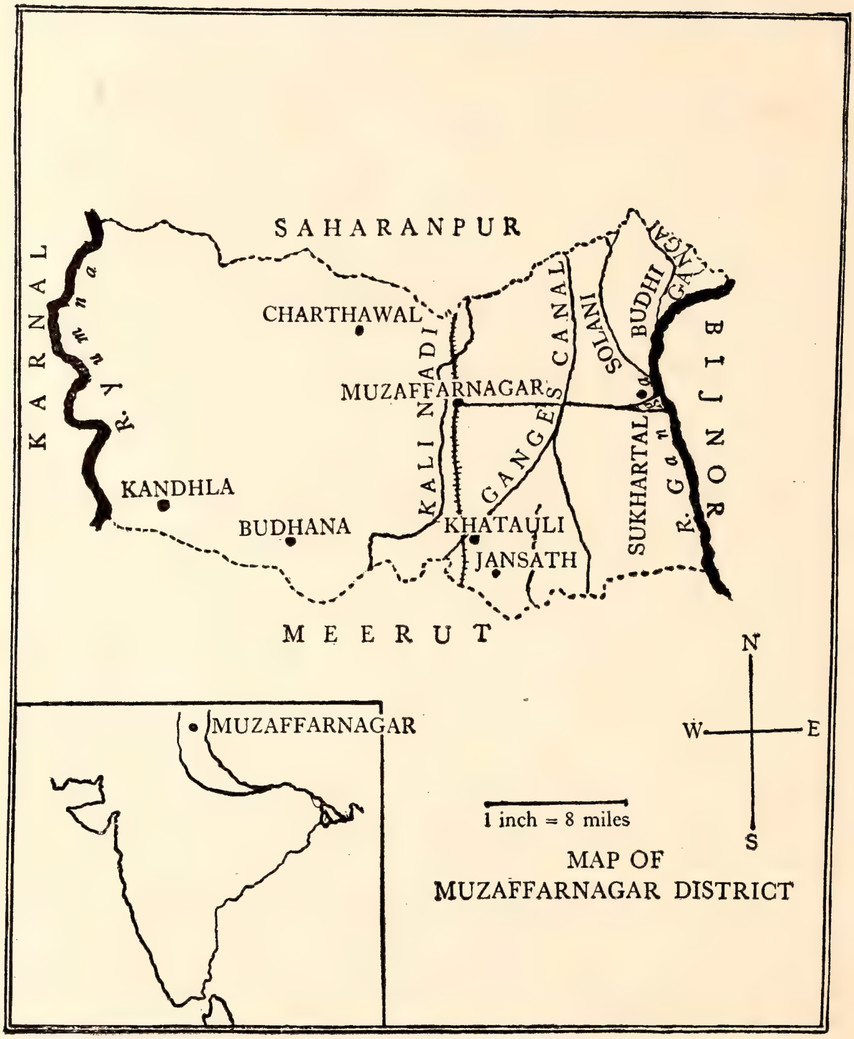
24° C. ; the maximum during the summer may rise to 46° C., the minimum may touch freezing point. *Loo* (hot wind) is prevalent during summer, in the greater part of May and June, till the break of the rains. Occasional frosts occur during winter.


SAHARANPUR
KARNAL
R. Yumna
CHARTHAWAL
KALI NADI
MUZAFFARNAGAR
GANGES CANAL
SOLANI
BUDHI GANGA
BIJNOR
SUKHARTAL
R. Ganga
KANDHLA
BUDHANA
KHATAULI
JANSATH
MEERUT
N
W
E
S
1 inch = 8 miles
MUZAFFARNAGAR

MAP OF
MUZAFFARNAGAR DISTRICT

VEGETATION

With the increase of population and consequent increase of cultivation, only a few areas exist where natural vegetation can be seen ; these are the Ganga 'Khadars' and 'Kholas', and the ravines of the Yumna and Ganga.

The ' Khadars ' are the low-lying water-logged areas along the banks of the Ganga. The natural vegetation comprises *Tamarix* sp., with occasional patches of *Butea monosperma* (Lamk.) Taub. mixed with *Phoenix* sp. The ' Kholas ' run adjacent to the ' Khadars ' with occasional trees of *Salmalia malabarica* Schott. & Endl. and undergrowth of *Adhatoda vasica* Nees, *Carissa spinarum* A. DC., and *Capparis decidua* (Forsk.) Pax ; the ravines along the rivers Yumna and Ganga in moist localities have *Acacia arabica* Willd., *Prosopis spicigera* L., with shrubs of *Capparis decidua* (Forsk.) Pax, *Capparis zeylanica* L., *Adhatoda vasica* Nees, and *Carissa spinarum* A. DC. On the low ' usar ' land, shrubs of *Calotropis procera* R.Br. with scattered trees of *Acacia arabica* Willd., *Butea monosperma* and *Azadirachta indica* A. Juss. can be seen. At some places trees are entirely absent and only few stunted grasses exist. On sandy and badly-drained soils one may find stunted trees of *Butea monosperma*. Where soil conditions are better *Acacia arabica* Willd. and *Dalbergia sissoo* Roxb. are present along the banks of the east Ganga canal.

Along the banks of the Ganga *Phoenix sylvestris-Butea monosperma* association is frequent and, if unhampered by biotic and edaphic factors, may pass to *Dalbergia sissoo-Acacia arabica* association. On the ravines in barren lands the first species to occur are the grasses, and as the soil and moisture conditions improve other plants, such as *Carissa spinarum* A. DC., *Adhatoda vasica* Nees, *Prosopis spicigera* L., and *Acacia arabica* Willd. occur.

Dudgeon (1920), while discussing the ecology of the Upper Gangetic Plain, distinguished four types of topographic succession, showing a developmental tendency to the climatic types. Since the distribution of rainfall and temperature during the year produce distinct climatic seasons, the physiological responses of the plants to the climate are well marked and have been described for the Gangetic Valley by Misra (1946), Verma (1936), Puri (1957), and others.

During the rainy season (July-September) the vegetation is luxuriant everywhere, and a closed community of *Boerhavia diffusa* L., *Indigofera enneaphylla* L., *Cynodon dactylon* Pers., *Evolvulus alsinoides* L., *Convolvulus pluricaulis* Chois., and *Justicia simplex* L. are commonly seen on the low-lying lands and cultivated fields. After the rains *Cassia tora* L., *Rungia pectinata* L., *Euphorbia thymifolia* Burm., *Convolvulus arvensis* L., *Vernonia cinerea* Less., *Sida rhombifolia* L., *Heliotropium indicum* L., *Croton bonplandianum* Baill. are most common. On the sides of the pools and puddles, where during the monsoons rain water gets stored, plants like *Cynodon dactylon* (L.) Pers., *Rumex dentatus* L., *Scirpus maritimus* L., *Polygonum plebejum* R.Br. are seen. November to February is the season for the growth of many annual and perennial grasses, but as the temperature decreases the process slows down and, when a few sporadic showers fall, they stimulate the growth of many winter annuals like *Spergula arvensis* L., *Fumaria indica* Pugsley, *Stellaria media* L., *Capsella bursa-pastoris* Medic., *Senebiera pinnatifida* DC., *Sisymbrium irio* L., *Artemisia scoparia* Waldst. & Kit., *Artemisia parviflora* Roxb., and *Vicoa indica* (Willd.) DC., etc. During March most of the woody plants flower. June is the worst season for the vegetation ; annuals die and the flora assumes typical desert aspect, with only a few species consolidating the soil against erosion. Common plants are *Capparis decidua* (Forsk.) Pax, *Capparis zeylanica* L., *Carissa carandas* L., *Prosopis spicigera* L., *Acacia arabica* Willd., *Zizyphus mauritiana* Lamk., *Randia spinosa* Thunb., *Calotropis procera* R.Br., and *Phoenix* sp. Thorny species predominate, affording protection against grazing to the vegetation growing near them.

Vegetation in the monsoon pools shows definite succession from submerged, floating leaf forms to amphibious forms. Common free-floating forms are *Ceratophyllum demersum* L., *Trapa bispinosa* Roxb., *Eichhornia crassipes* Solms., and *Azolla pinnata.* Submerged plants are *Hydrilla verticillata* Royle, *Potamogeton pectinatus* L., *Vallisneria spiralis* L., and *Chara* sp. Common fixed aquatic plants include *Typha elephantina* Roxb., *Ranunculus sceleratus* L., *Scirpus maritimus* L., *Polygonum glabrum* Willd., etc. During summer months the water dries up and mud communities develop in the centre of these pools.

LIST OF PLANTS COLLECTED

The following is a list of the plants collected from the area, arranged according to Bentham & Hooker's system of classification. Where nomenclatural changes have been made, the correct name is given first, then the name given in Duthie's FLORA OF THE UPPER GANGETIC PLAIN AND OF THE ADJACENT SIWALIK AND SUB-HIMALAYAN TRACTS (1903-1920). The numbers given after the plants refer to collections made by the author. Plants marked with an asterisk have not been mentioned by Duthie in his FLORA. Some of these plants have been recently reported by Sri M. B. Raizada (1931-1958) ; they are really exotics but have now become completely naturalised in the area.

Ranunculaceae

Ranunculus sceleratus Linn.

Erect annual with pale yellow flowers, near water streams and moist places. (Gupta 116, 148D, 357, 358)

Menispermaceae

Cissampelos pareira Linn.

Lofty climber, flowers green. May-August. (Gupta 551)

Nymphaeaceae

Nymphaea stellata Willd.

Aquatic herb with white flowers. August-October. In ponds throughout the district. (Gupta 641)

Nelumbo nucifera Gaertn.

Aquatic herb with rosy-red flowers. Cultivated in tanks near the temples.

Papaveraceae

Argemone mexicana Linn.

Prickly annual with yellow flowers. March-May ; in waste places and roadsides. (Gupta 170, 342)

Fumariaceae

Fumaria indica Pugsley. (*F. parviflora* Lamk.)

Pale green diffuse herb with rose coloured flowers. January-March ; in fields and moist shady places. (Gupta 50, 344, 345)

Cruciferae

Capsella bursa-pastoris Medic.

Annual with white flowers. July-August ; in fields and moist places. (Gupta 353)

Senebiera pinnatifida DC. (*S. didyma* Pers.)

Annual, leaves pinnatifid with strong smell when bruised. Flowers white, petals dissimilar. January-March ; on moist places. (Gupta 350)

Sisymbrium irio Linn.

Annual ; flowers yellow. January-March. (Gupta 355)

Sisymbrium thalianum Gay & Monn.

Annual, flowers white. January-March ; it is reported to occur between 5000 and 10,000 ft. (1525 to 3050 m.) by Hooker but seems to have come down recently.

Capparidaceae

Capparis decidua (Forsk.) Pax. (*Capparis aphylla* Roth)

Much-branched shrub. Flowers red-brown. April-July ; in waste places and ravines of the Yumna and Ganga. (Gupta 346, 347)

Capparis zeylanica Linn. non Hk. f. & Th. (*C. horrida* Linn. f.)

A shrub with stout recurved thorns. Flowers white. Common on roadsides and fallow fields.

Cleome viscosa Linn.

Annual ; flowers yellow. July-September ; in waste places. (Gupta 522)

Gynandropsis gynandra (L.) Briq. (*G. pentaphylla* DC.)

Glandular pubescent herb, flowers purplish yellow. July-September ; in waste places. Leaves have peculiar smell. (Gupta 154, 349, 426)

Caryophyllaceae

Stellaria media Linn.

Annual, flowers white, star-like; in cymes. February-April; in moist places. (Gupta 315)

Silene conoidea Linn.

Glandular pubescent annual, flowers pink. February-March. (Gupta 180)

Dianthus chinensis Linn.

Perennial herb, flowers solitary terminal. February-March. (Gupta 553)

Saponaria vaccaria Linn.

Annual decumbent herb, flowers white. February-April; in fields. (Gupta 318)

Arenaria serpyllifolia Linn.

Annual decumbent herb, flowers white. February-April. (Gupta 317)

Spergula arvensis Linn.

Annual with linear subulate leaves in whorls, looking like that in *Chara* sp., flowers white. January-March; in moist places. (Gupta 321)

Polycarpaea corymbosa Lamk.

Annual or perennial herb with white flowers. August-November, in cultivated fields. (Gupta 642)

Portulacaceae

Portulaca quadrifida Linn.

Annual, flowers yellow, solitary terminal. (Gupta 554)

Tamaricaceae

Tamarix dioica Roxb.

Small tree with pink flowers. Near the east Ganga Canal and elsewhere near water.

Malvaceae

Sida acuta Burm.

Undershrub with yellow flowers. September-October; on roadsides and waste places. (Gupta 335)

Sida cordifolia Linn.

Erect undershrub, flowers yellow. August-September; on roadsides. (Gupta 333)

Sida rhombifolia Linn.

Erect undershrub, leaves rhomboid, flowers yellow. September-October. (Gupta 324)

Malvastrum coromandelianum (L.) Garcke. (*M. tricuspidatum* A. Gray)

Erect herb, flowers yellow. September. (Gupta 473)

Urena lobata Linn.

Erect undershrub, flowers pink. August-September. (Gupta 337, 340 432A)

Malva parviflora Linn.

Spreading annual, flowers pale pink. May-June. (Gupta 330, 331)

Abutilon indicum G. Don.

Annual, flowers yellow, opening in the evening only. March-September. (Gupta 338, 462A)

Abutilon polyandrum W. & A.

Densely pubescent annual, flowers orange-yellow. September-December. (Gupta 329)

Hibiscus vitifolius Linn.

Annual, leaves 3-5 lobed, flowers yellow, with purple spot. Cultivated. (Gupta 341)

Bombacaceae

Salmalia malabarica Schott. & Endl. (*Bombax malabaricum* DC.)

Large tree with spreading branches and red crimson flowers. January-March.

Sterculiaceae

Firmiana fulgens (Wall. ex Mast.) Corner. (*Sterculia fulgens* Wall. ex Mast.)

Small tree, flowers covered with yellowish down. Cultivated. (Gupta 61)

Sterculia villosa Roxb.

Tree with velvety leaves, cultivated. (Gupta 463)

Tiliaceae

Grewia subinaequalis Wall. (*G. tiliaefolia* Vahl.)

Tree with purplish branches and feather-veined leaves. Drupe small. Flowers March-May. (Gupta 480)

Corchorus aestuans Linn. non Forsk. (*C. acutangulus* Lamk.)

Annual herb, flowers yellow. August-September ; in waste places. (Gupta 421, 454A)

Corchorus olitorius Linn.

Annual, flowers yellow. August-September. (Gupta 555)

Triumfetta bartramia Linn. (*T. rhomboidea* Jacq.)

Suffruticose annual, flowers yellow. August-September. (Gupta 336)

Zygophyllaceae

Tribulus terrestris Linn.

Annual prostrate herb, flowers yellow. May-July. Cocci with two long and two short spines. In waste places and along railway lines. (Gupta 446)

Geraniaceae

Oxalis repens Thunb. (*O. corniculata* Linn.)

Perennial herb, flowers yellow. March-April. (Gupta 556)

***Oxalis latifolia** H.B.K.

Erect herb, flowers pink. May-July. (Gupta 440D)

Impatiens balsamina Linn.

Herb, flowers pink. August-September. (Gupta 557)

Rutaceae

Murraya paniculata Jacq. (*M. exotica* Linn.)

Shrub, flowers white. August-September. (Gupta 466)

Murraya koenigii Spreng.

Strongly scented shrub, flowers white. April-May. (Gupta 558)

Aegle marmelos Corr.

Small tree with greenish-white, sweet scented flowers. Wild and also cultivated for the fruits and leaves.

Meliaceae

Azadirachta indica Juss. (*Melia azadirachta* Linn.)

A large tree commonly seen on the roadside. Flowers white.

Rhamnaceae

Zizyphus mauritiana Lamk. (*Z. jujuba* Lamk. non Mill.)

Trees or shrubs, flowers greenish yellow. September; on ravines. (Gupta 167, 185)

Zizyphus xylopyra Willd.

Straggling shrub, flowers greenish yellow. April-May. (Gupta 559)

Sapindaceae

Dodonaea viscosa Linn.

Evergreen shrub. Cultivated as hedge plant. (Gupta 208)

Anacardiaceae

Mangifera indica Linn.

A large tree with yellow, odorous flowers. Common on roadsides and in gardens. (Gupta 508)

Leguminosae

Crotalaria medicaginea Lamk.

Diffuse perennial herb, flowers yellow. April-September. (Gupta 284, 328)

Crotalaria mysorensis Roth.

Densely silky perennial herb, flowers yellow. July-September. (Gupta 290, 313)

Crotalaria juncea Linn.

Shrub, flowers bright yellow. Cultivated for the fibre, sometimes wild also. (Gupta 264)

Melilotus indica All. (*M. parviflora* Desf.)

Annual, flowers pale yellow. March-April. (Gupta 273, 296, 308)

Melilotus alba Lamk.

Annual, flowers white. October-December; in shady places. (Gupta 178, 272)

Medicago lupulina Linn.

Herb, flowers yellow. January-February.

***Medicago sativa** Linn.

Herb, branched copiously, flowers yellow. June-July. (Gupta 281)

Desmodium gangeticum DC.

Undershrub, flowers whitish. June-July; in moist places. (Gupta 280, 434A)

***Desmodium floribundum** G.Don.

Undershrub, flowers lilac. July-August. (Gupta 294)

Dalbergia sissoo Roxb.

Erect tree with roundish 3-5 leaflets, flowers yellowish. March-May. (Gupta 266)

Dolichos lablab Linn.

Annual twiner, flowers reddish. Cultivated for the pod. (Gupta 301)

Alysicarpus rugosus DC.

Annual, flowers flesh-coloured. August-September. (Gupta 428)

Alysicarpus bupleurifolius DC.

Annual, flowers pink. August-September. (Gupta 265)

Lathyrus aphaca Linn.

Annual herb with abortive leaflets, flowers yellow. March-April. (Gupta 177, 304)

Lathyrus sativus Linn.

Annual, flowers reddish purple. January. (Gupta 168, 302)

Abrus precatorius Linn.

Climber with reddish flowers in racemes. August-September. (Gupta 560)

Sesbania bispinosa (Jacq.) W.F. Wight. (*S. aculeata* Pers.)

Annual shrub with pale yellow flowers, standard dotted with red. December-February. (Gupta 173A)

Sesbania sesban (L.) Merr. (*S. aegyptiaca* Poir.)

Perennial soft-wooded shrub, flowers pale yellow, tinged with red. December-February. (Gupta 28, 285, 311A)

Teramnus labialis Spreng.

Climber with reddish flower. (Gupta 262)

Cajanus cajan (L.) Mill. (*C. indicus* Spreng.)

Erect shrub with yellow flowers. Cultivated for the pulse obtained from the seeds. (Gupta 288, 295, 310, 312)

Phaseolus mungo Linn.

Sub-erect annual, clothed densely with loose deflexed hairs, flowers yellow. Cultivated. (Gupta 301)

Clitoria ternatea Linn.

Climber, flowers bright blue, with orange centre. September-October. (Gupta 271)

Tephrosia purpurea Pers.

Sub-erect perennial shrub, flowers red-purple. July-September (Gupta 404)

Vicia tenera Grah.

Climber, flowers pale yellow. March-April. (Gupta 156)

Vicia sativa Linn.

Annual sub-erect herb, flowers red-blue. Cultivated. (Gupta 286, 300)

Atylosia scarabaeoides Benth.

Twiner, flowers yellow. August-September. (Gupta 267)

Trifolium repens Linn.

Trailing herb, flowers white in globose heads. March-July. (Gupta 269, 282)

Butea monosperma (Lamk.) Taub. (*Butea frondosa* Koen. ex Roxb.)

An erect tree, commonly seen as scrub on sandy and badly drained soils throughout the district. Flowers yellow ; February-May.

Indigofera enneaphylla Linn.

An annual, much-branched, spreading herb with small red flowers. July-October. Common on grassy areas.

Trigonella foenum-graecum Linn.

An annual herb with yellow flowers. Cultivated for the leaves, used as pot herb ; sometimes found as escape.

Cassia occidentalis Linn.

Diffuse undershrub, flowers yellow, petals with reddish veins. July-September. (Gupta 268, 305, 407, 464)

Cassia sophera Linn.

Diffuse shrub, flowers orange-yellow. July-September. (Gupta 274, 277, 287)

Cassia tora Linn. (*C. obtusifolia* Linn.)

Gregarious annual with orange-yellow flowers. July-August. (Gupta 561)

Cassia mimosoides Linn.

Diffuse perennial, flowers yellow. July-August. (Gupta 260, 297)

Cassia javanica Linn.

Shrub, flowers yellow. Cultivated. (Gupta 212, 311B)

Bauhinia purpurea Linn.

Erect tree, flowers reddish, in terminal corymbs. September-November. (Gupta 261)

Caesalpinia bonducella (L.) Fleming

Prickly shrub, flowers yellow. April-September. (Gupta 270)

Caesalpinia pulcherrima Swartz

Shrub with few prickles, flowers reddish yellow. Cultivated. (Gupta 259)

Prosopis spicigera Linn.

Low prickly tree, flower heads in axillary spikes. July-September. (Gupta 363)

Acacia arabica Willd.

Common spiny tree, flowers yellow. July-September. Common on the ravines and 'usar' lands conserving soil against erosion.

Pithecellobium dulce Benth.

Spiny shrub, flowers yellow. Commonly grown as hedge plant.

Rosaceae

Fragaria indica Andr.

Perennial herb, flowers yellow. June-July. (Gupta 562)

Eriobotrya japonica Lindl.

Large tree with white fragrant flowers ; November-January. Cultivated for the fruits.

Combretaceae

Terminalia belerica Roxb.

Tree with flowers in solitary axillary spikes. Cultivated on the roadsides and in avenues.

Terminalia chebula Retz.

Tree with flowers in terminal spikes. Cultivated on roadsides and in avenues.

Quisqualis indica Linn.

A sub-scandent shrub with flowers in short axillary and terminal spikes. The flowers are white when they open, soon becoming red. Monkeys are very fond of the leaves. Cultivated in gardens.

Myrtaceae

Psidium guajava Linn.

Small tree with white flowers. Commonly cultivated in gardens for the fruit.

Syzygium cumini (Linn.) Skeels. (*Eugenia jambolana* Lamk.)

Large tree with a thick and crooked trunk. Cultivated on the roadsides and in avenues for shade and for the fruits.

Lythraceae

Ammannia multiflora Roxb.

Annual herb, flowers in compound peduncled cymes. (Gupta 56)

Lawsonia alba Lamk.

Spinous shrub, flowers white. Cultivated as hedge.

Onagraceae

Trapa bispinosa Roxb.
A floating herb commonly cultivated in tanks for the fruit.

Cucurbitaceae

Melothria maderaspatana Cogn.
Annual herb, flowers yellow. July-August. (Gupta 256)

Coccinia indica Wt. & Arn.
Climber, flowers white. September-December. (Gupta 258)

Trichosanthes bracteata (Lamk.) Voigt. (*T. palmata* Roxb.)
Climber, flowers white. July-August. (Gupta 257)

Brynopsis laciniosa Naud.
Slender twiner, flowers greenish yellow. September-October. (Gupta 255)

Momordica dioica Roxb.
Climber with yellow flowers. July-August. (Gupta 563)

Ficoideae

Trianthema monogyna Linn.
Prostrate herb. Flower solitary. July-September. (Gupta 307)

Umbelliferae

Centella asiatica (L.) Urb. (*Hydrocotyle asiatica* Linn.)
Prostrate herb, rooting at the nodes, flowers July-August. (Gupta 564)

Rubiaceae

Wendlandia exserta DC.
Small tree with white fragrant flowers. March-April. (Gupta 468)

Borreria stricta (Linn. f.) Schum. (*Spermacoce stricta* Linn. f.)
Annual erect herb with white flowers. August-September. (Gupta 565)

Borreria hispida (L.) Schum. (*Spermacoce hispida* Linn.)
Annual procumbent herb with white flowers. July-August. (Gupta 209)

Rubia cordifolia Linn. var. **munjista** Miquel.
Perennial climber. Flowers dark red. July-August. (Gupta 566)

***Leptodermis lanceolata** Wall.
Erect shrub with white flowers; cultivated. (Gupta 532)

Oldenlandia diffusa Roxb.
Annual herb with white flowers. July-August. (Gupta 567)

Oldenlandia corymbosa Linn.
Annual herb with white flowers. August-September. (Gupta 568)

Randia spinosa (Thunb.) Poir. (*R. dumetorum* Lamk.)

Large spiny shrub with white flowers. May-June. (Gupta 569)

Hamelia patens Jacq.

Evergreen shrub with reddish flowers. Cultivated in gardens.

Compositae

Vernonia cinerea Less.

Erect herb with pink flowers. March-April. (Gupta 230, 241, 249, 414, 447A)

Ageratum conyzoides Linn.

Softly hairy annual with pale blue flowers. March-April. (Gupta 159)

Erigeron canadensis Linn.

Erect annual with flowers having pale rose ligules. August. (Gupta 234)

***Erigeron linifolius** Willd.

Hairy annual with flower heads having purple ray florets. August. (Gupta 570)

Blumea membranacea DC.

Glandular pubescent annual with yellow florets. April-May. (Gupta 235)

Blumea aromatica DC.

Aromatic, glandular shrub-like herb with yellow flowers and red pappus. April-May. (Gupta 232, 242, 253, 409)

Gnaphalium indicum Linn.

Slender woolly herb with small flower heads in spikes. February-March. (Gupta 245, 247)

Caesulia axillaris Roxb.

A semi-aquatic herb with white flowers in compound heads. September-October (Gupta 192, 233, 246, 410)

Pulicaria crispa Schultz.

Shrubby perennial with yellow flowers. February-March. (Gupta 221)

Xanthium strumarium Linn.

Coarse herb with fruits covered with hooked bristles. August-September. (Gupta 182, 441)

Siegesbeckia orientalis Linn.

Pubescent annual with yellow flowers. September-October. (Gupta 572)

Eclipta prostrata Linn. (*E. erecta* Linn.)

Strigose slender herb with white flowers. August-September. (Gupta 53, 406)

Bidens biternata (Lour.) Merr. & Sherff.

Erect annual with yellow flowers. August-September. (Gupta 236, 250, 472)

Tridax procumbens Linn.

Perennial straggling herb with yellow flowers. April-May. (Gupta 411A)

***Artemisia scoparia** Waldst. & Kitt.

Herb with yellow flowers. September-October. (Gupta 243)

***Artemisia parviflora** Roxb.

Tall herb with wedge-shaped leaves. Flowers : August-September. Recently come down. (Gupta 573)

Emilia sonchifolia DC.

Slender herb with pinkish-violet flowers. February-March. (Gupta 219, 251)

Launaea nudicaulis Hook. f.

Glabrous perennial with yellow flowers in cold months.

Launaea asplenifolia Hook. f.

Glabrous herb with yellow flowers in cold months.

Adenostemma lavenia (Linn.) O. Kuntze. (*A. viscosum* Forst.)

Annual herb with white flowers. August-September. (Gupta 574)

Sonchus oleraceus Linn.

Annual herb with yellow flowers. March-April. (Gupta 201)

Sonchus arvensis Linn.

Perennial with yellow flowers. March-April. (Gupta 89D)

Vicoa indica DC. (*V. auriculata* Cass., *Inula indica* Linn.)

Viscidly pubescent herb with orange-yellow flowers. (Gupta 198, 224, 225, 440A)

Vicoa vestita Benth. (*Inula vestita* Wall.)

Softly hairy herb with bright yellow heads. (Gupta 222)

Centaurea cyanus Linn.

Erect cottony herb with large blue ray florets. Cultivated but naturalised in the area. (Gupta 226)

***Tanacetum vulgare** Linn.

Robust perennial with yellow heads. Recently naturalised in the area. (Gupta 244)

***Gamolepis annua** Less.

Glabrous wiry annual with bright yellow heads. Naturalised recently in the area. (Gupta 228)

***Carthamus oxyacantha** Bieb.

Thistle-like herb with orange-yellow flowers. (Gupta 408)

Taraxacum officinale Wigg.

Herb with yellow flowers. (Gupta 575)

Centipeda oribicularis Lour.

Prostrate woolly annual with yellow flowers ; November-February. In fields and waste places. (Gupta 644)

Solidago virga-aurea Linn.

Perennial herb with yellow flowers. (Gupta 645)

Siegesbeckia orientalis Linn.

A pubescent annual with yellow flowers. On the edges of the rice fields and in shady places. (Gupta 646)

Spilanthes acmella Linn.

Annual herb with yellow-white flowers. In waste places. (Gupta 647)

Plumbaginaceae

Plumbago zeylanica Linn.

Sub-scandent perennial herb with white flowers in spike-like racemes. August-September. (Gupta 576)

Primulaceae

Anagallis arvensis Linn.

Annual herb with blue flowers. February-March. (Gupta 173, 319, 69D)

Oleaceae

Jasminum pubescens Willd.

Scandent shrub with white fragrant flowers. December-April. (Gupta 445)

Olea cuspidata Wall.

Tree with flowers in April-May. Cultivated. (Gupta 467)

Apocynaceae

Carissa carandas Linn.

Evergreen shrub with white faintly scented flowers. April-June. (Gupta 188)

Lochnera pusilla K. Sch.

Erect annual with white or pink flowers. (Gupta 439)

Ichnocarpus frutescens R.Br.

Evergreen climbing shrub with greenish-white flowers. August-December. (Gupta 186, 210, 534)

Carissa spinarum Linn.

An evergreen shrub with scented, white flowers April-June. In dry situations. (Gupta 188)

Nerium odorum Soland.

An evergreen shrub with milky juice. Flowers fragrant, rose-red ; April-June. Cultivated near temples, often found as escape.

Thevetia peruviana (Pers.) K. Schum. (*T. neriifolia* Juss.)

Evergreen shrub with milky juice. Flowers bright yellow ; throughout the year. Often grown as fences in gardens and near temples.

Plumeria acutifolia Poir.

Small tree with white, fragrant flowers. Planted near temples and in gardens.

Asclepiadaceae

***Asclepias curassavica** Linn.

Undershrub with bright orange flowers. August-September. (Gupta 578)

Calotropis procera R.Br.

Large shrub with pink flowers having purple spots. March-May. (Gupta 577)

Cryptolepis buchanani R. & S.

Twining shrub with pale greenish-yellow flowers. March-April. (Gupta 589)

Leptadenia reticulata W. & A.

Twiner with pale brown flowers. May-July. (Gupta 590)

Leptadenia pyrotechnica Decne. (*L. spartium* Wight)

Erect leafless shrub with yellow flowers. December-January. (Gupta 62)

Marsdenia volubilis (Linn. f.) Cooke. [*Wattakaka volubilis* (Linn. f.) Stapf]

Twining shrub with yellowish-green flowers in drooping axillary cymes. April-June. (Gupta 507)

Pergularia daemia (Forsk.) Chiov. (*Daemia extensa* R. Br.)

A foetid climber with flowers pale yellowish-green and red. (Gupta 62)

Loganiaceae

Buddleia asiatica Lour.

An evergreen shrub with white scented flowers. March-April. (Gupta 15)

Boraginaceae

Ehretia laevis Roxb.

Small tree with white flowers. February-April. (Gupta 187)

Cordia myxa Linn.

Tree with white flowers. March-April. Often planted.

Trichodesma indicum R.Br.

Bulbous based hairy, annual herb with pale blue flowers changing to white. December-February. (Gupta 206, 436)

Heliotropium indicum Linn.

Hairy diffuse annual with white flowers. October. (Gupta 214)

Cynoglossum zeylanicum Thunb. (*C. denticulatum* var. *zeylanica* Clke.)

Annual herb with dark blue flowers. October-November. (Gupta 592)

Convolvulaceae

Cuscuta reflexa Roxb.

Parasitic twining herb with white flowers. September-February. (Gupta 38D)

Evolvulus alsinoides Linn.

Diffuse perennial with white or blue flowers. July-November. (Gupta 593)

Convolvulus arvensis Linn.

Pubescent annual with pink flowers having a pale yellow centre. December-February. (Gupta 594)

Convolvulus pluricaulis Chois.

Diffuse perennial with pale rosy flowers. December-February. (Gupta 595)

Ipomoea pilosa Sweet

An annual twiner with purple flowers (Gupta 648)

Ipomoea nil (Linn.) Roth. (*I. hederacea* Jacq.)

An annual twining herb with blue flowers, tinged with pink. In the villages flowering in the morning in winters. (Gupta 649)

Ipomoea palmata Forsk.

A perennial twiner with purple flowers. Often on trees in gardens. (Gupta 650)

Solanaceae

Solanum xanthocarpum Schrad. & Wendl.

Prickly perennial with bluish-purple flowers. March-April. (Gupta 529)

Solanum nigrum Linn.

Annual with small white flowers. June-July. (Gupta 445A)

Physalis minima Linn.

Annual with yellow flowers. May-August. (Gupta 527)

Datura stramonium Linn.

Coarse annual with large white flowers. (Gupta 526)

***Nicotiana plumbaginifolia** Viv.

Annual herb with white flowers. August-September. (Gupta 596)

***Cestrum nocturnum** Linn.

Sub-scandent evergreen shrub with pale yellowish-green flowers fragrant at night. (Gupta 536)

Scrophulariaceae

Lindenbergia indica (Lehm.) O. Kze. (*L. urticaefolia* Link & Otto)

Glandular hairy annual with yellow flowers. August-September. (Gupta 600)

Lindernia nummularifolia (Roxb.) Wett. (*Vandellia nummularifolia* Don)

Herb with reddish-purple flowers. August-September. (Gupta 602)

Lindernia crustacea (L.) F. V. Muell. (*Vandellia crustacea* Benth.)

Annual with purplish-white flowers. August-September. (Gupta 605)

Lindernia ciliata (Colsmann) Pennell. (*Bonnaya brachiata* Link & Otto)

Herb with pink or white flowers. August-September. (Gupta 604)

Lindernia anagallis (Burm.) Pennell. (*Bonnaya veronicifolia* Spr.)

Herb with violet flowers. October-November. (Gupta 608)

Verbascum coromandelianum (Vahl.) O.Kze. (*Celsia coromandeliana* Vahl.)

Annual herb with yellow flowers. December-February. (Gupta 610)

Verbascum thapsus Linn.

Stellate tomentose herb with pale yellow flowers on the banks of Kali River. April.

Antirrhinum orontium Linn.

Herb with pale pink flowers. December-February. (Gupta 615)

Mazus japonicus (Thunb.) O.Kze. (*M. rugosus* Lour.)

Annual with pale blue flowers. August-September. (Gupta 443)

Stemodia viscosa Roxb.

Viscidly pubescent aromatic herb with violet flowers. December-February, in moist localities. (Gupta 619)

Torenia cordifolia Roxb.

Annual with bluish-purple flowers. August-September. (Gupta 621)

***Torenia fournieri** Linden.

Much-branched herb with pale violet flowers, yellow on back. Naturalised in the area. (Gupta 440, 449A)

Scoparia dulcis Linn.

Undershrub with white flowers. August-September. Weed of cultivated land. (Gupta 444A)

Veronica agrestis Linn.

Annual with blue flowers. December-February. (Gupta 205)

Veronica anagallis Linn.

Herb with pale purple flowers. December-February. (Gupta 83D)

Striga euphrasioides Benth.

Annual with white flowers; in sugarcane fields. (Gupta 612)

***Bacopa monnieri** (L.) Pennell

Creeping herb, rooting at the nodes with purplish-pink flowers. The plant resembles *Centella asiatica* and prefers swampy localities.

Kickxia ramosissima (Wall.) Janchen. (*Linaria ramosissima* Wall.)

Perennial herb with yellow flowers in ravines and dry localities. (Gupta 434, 438)

Orobanchaceae

Aeginetia indica Linn.

Parasitic leafless herb tinged with purple having solitary purple flower. (Gupta 627D)

Orobanche aegyptiaca Pers.

A leafless parasitic herb, branching from the base of the stem; flowers blue. Common in mustard fields. (Gupta 651)

Bignoniaceae

Kigelia pinnata DC.

Ornamental tree with maroon-coloured flowers on long pendant racemes; on roadsides. (Gupta 450)

Pedaliaceae

Martynia annua Linn. (*M. diandra* Glox.)

Tall herb with rose-coloured flowers. Fruit beaked by two strong curved spines. (Gupta 511, 427A)

Acanthaceae

Hygrophila polysperma T. Anders.

Procumbent branched herb with pale blue flowers. July-September. (Gupta 174)

Eranthemum nervosum (Vahl.) R.Br. (*Daedalacanthus nervosus* T. Anders.)

Herb with deep blue flowers often cultivated. (Gupta 528)

Phlogacanthus thyrsiflorus Nees

Evergreen shrub with orange-coloured flowers. March-April. (Gupta 469)

Barleria dichotoma Roxb.

Small undershrub with blue-purple flowers. August-September. (Gupta 175)

Justicia simplex Linn.

Small herb with pale purple flowers. August-September.

Adhatoda vasica Nees. (*Justicia adhatoda* Linn.)

Evergreen shrub with white flowers, corolla with pink or purple thread. February-May. (Gupta 162)

Peristrophe bicalyculata Nees

Herb with pink flowers. August-September. (Gupta 457 D)

Rungia pectinata (L.) Nees. (*R. parviflora* Nees var. *pectinata* Clke.)

Annual herb with bluish white flowers. July-September. (Gupta 469 A & B)

Dicliptera bupleuroides Nees. (*D. roxburghiana* Nees var. *bupleuroides*)

Herb with pink flowers. (Gupta 625)

Verbenaceae

Lantana camara Linn.

Prickly shrub with orange flowers. March-April. (Gupta 626)

Lantana indica Roxb.

Shrub with white, pale and yellow flowers. August-September. (Gupta 422 A)

Callicarpa macrophylla Vahl.

Erect shrub with rosy flowers. July-September. (Gupta 424)

Vitex negundo Linn.

Shrub with bluish flowers. July-August. (Gupta 638)

Clerodendrum serratum Spreng.

Shrub with blue-purple flowers. April-August. (Gupta 627)

Clerodendrum infortunatum Linn.

Shrub with white flowers tinged with pink. December-April. (Gupta 476)

***Clerodendrum fragrans** R.Br.

Undershrub with white-pink flowers. Cultivated. (Gupta 216)

Clerodendrum phlomidis Linn. f.

A large shrub with white or pink flowers. In hedges. (Gupta 652)

Duranta plumieri Jacq.

Erect spiny shrub with blue flowers. Cultivated as hedge. (Gupta 293, 294, 450 D)

***Caryopteris incana** Miq. (*Caryopteris mestacanthus* Schauer)

Small shrub with violet-blue flowers. Cultivated. (Gupta 499, 509)

Labiatae

Ocimum sanctum Linn.

Herb with purplish-pink flowers. Sacred and cultivated in houses. (Gupta 520)

Ocimum basilicum Linn.

Herb with white-pink flowers. (Gupta 204, 419 D)

Ocimum gratissimum Linn.

Shrub with greenish yellow flowers. (Gupta 531)

Ocimum americanum Linn. (*O. canum* Sims.)

Herb with white flowers. (Gupta 514)

Anisomeles indica (Linn.) O. Kuntze. (*A. ovata* R.Br.)

Herb with pale purple and bluish flowers. September-October. (Gupta 176, 523)

Leucas aspera Spreng.

Annual with white flowers. August-September. (Gupta 515)

Leucas cephalotes Spreng.

Annual with white flowers in dense globose heads. July-September. (Gupta 435A, 517)

Leucas urticaefolia R. Br.

A hairy annual with white flowers in dense globose whorls. (Gupta 77 D)

Leonotis nepetaefolia R.Br.

Tall annual with orange-scarlet flowers in globose whorls. October. (Gupta 497)

Salvia pseudo-coccinea Jacq. (*S. coccinea* Juss.)

Slender herb with scarlet flowers. March-April; escape. (Gupta 500, 502)

***Salvia farinacea** Benth.

Perennial herb with many clustered stems and violet-blue flowers, becoming naturalised in the area. (Gupta 503)

Ajuga bracteosa Wall.

Perennial with pale blue flowers. August-September. (Gupta 628)

Ajuga macrosperma Wall. ex Benth.

Decumbent annual with blue flowers. March-April. (Gupta 524)

Mentha piperita Linn.

Aromatic herb with blue flowers along the water course. July-August. (Gupta 629)

Nepeta hindoostana (Roth.) Haines. (*N. ruderalis* Buch.-Ham.)

Pubescent annual with bluish-purple flowers. March-April. (Gupta 183, 416, 519, 521)

Plantaginaceae

Plantago major Linn.

Perennial with small flowers. June-July. (Gupta 213, 460)

Nyctaginaceae

Boerhavia repens Linn. var. **diffusa** (*B. diffusa* Linn.)

Diffusely branched herb with small pink flowers. March-April (Gupta 54A, 405, 525)

Amaranthaceae

Deeringia amaranthoides (Lamk.) Merril (*D. celosioides* R.Br.)

Climbing shrub with pale yellowish-green flowers. August-September. (Gupta 422)

Celosia argentea Linn.

Annual with pink flowers when young. September-October. (Gupta 447, 425)

Digera muricata (L.) Mart. (*D. arvensis* Forsk.)

Slender annual with pink flowers. September-October. (Gupta 439A, 452A, 454, 455)

Amaranthus spinosus Linn.

Spinous shrub with greenish-white flowers. March-April. (Gupta 200)

Amaranthus gracilis Desk.

Annual with green flowers. March-April. (Gupta 446A, 453)

Aerva sanguinolenta Blume. (*A. scandens* Wall.)

Climbing undershrub with silvery flowers. March-April. (Gupta 172, 446, 448)

Nothosaerva brachiata Wight

Slender annual with glistening white flowers. July-August. (Gupta 449)

Achyranthes aspera Linn.

Weed with greenish-white flowers in terminal spike. July-August. (Gupta 412D)

Pupalia lappacea Juss.

Straggling undershrub with pink flowers in terminal spike. September-October. (Gupta 423, 468A,B)

Alternanthera echinata Smith

A biennial herb with small flowers, in dense axillary spike-like clusters. On roadsides and backyards of houses. (Gupta 518)

Chenopodiaceae

Chenopodium album Linn.

Herb with greenish flowers in clusters forming panicled spikes. August-September. (Gupta 630)

Chenopodium murale Linn.

Foetid herb with flowers in dense cymes in axillary raceme. August-September. (Gupta 452)

Polygonaceae

Polygonum plebejum R.Br.

Prostrate herb with pink flowers. July-August. (Gupta 197, 459)

Polygonum alatum Buch.-Ham.

Procumbent annual with flowers in heads. July-September. (Gupta 457)

Polygonum glabrum Willd.

Erect annual with pink flowers. August-September. (Gupta 458)

***Polygonum chinense** Linn.

Herb about 5 ft. with flowers in heads. October-November. (Gupta 479)

Polygonum serrulatum Lagasc.

Annual with white flowers. August-September. (Gupta 467)

Rumex dentatus Linn.

Erect annual with green flowers changing to red. September-October. (Gupta 631)

Loranthaceae

Dendropthöe falcata (Linn. f.) Etting. (*Loranthus longiflorus* Desr. var. *falcata*)

Parasitic shrub with orange-red flowers on mango and guava. (Gupta 198)

Euphorbiaceae

Euphorbia microphylla Heyne ex Roth.

An annual herb with small leaves. In waste places. (Gupta 471D)

Euphorbia tirucalli Linn.

A small tree with spreading terete rush-like leafless branches. Often seen as hedge plant in villages. (Gupta 653)

Euphorbia pulcherrima Willd.

A shrub, much cultivated in the gardens throughout the district.

Euphorbia dracunculoides Lamk.

Much-branched annual. April-June. (Gupta 485, 490)

Euphorbia hypericifolia Linn.

Decumbent annual, flowering throughout year. (Gupta 495)

Euphorbia thymifolia Linn.

Small annual herb flowering greater part of the year. (Gupta 471 A & B)

Euphorbia hirta Linn. (*E. pilulifera* Jacq.)

Annual herb, with flowers. April-September. (Gupta 443a, 494)

Euphorbia prostrata Ait.

Herb with many slender prostrate stems resembling *E. microphylla* Heyne ex Roth. in habit. (Gupta 486)

Euphorbia geniculata Orteg.

Annual herb with flowers August-September. (Gupta 460 A)

Emblica officinalis Gaertn. (*Phyllanthus emblica* Linn.)

A moderate-sized tree, often planted near the villages for its fruit and near temples, since it is held sacred.

***Croton bonplandianum** Baill. (*C. sparsiflorus* Morung.)

Annual weed with white flowers in waste places. (Gupta 489)

Ricinus communis Linn.

Tall tree-like shrub with large flowers in racemes. February-March.

***Jatropha panduraefolia** Andr.

Shrub with rose-pink flowers. Cultivated. (Gupta 487)

Phyllanthus niruri Linn.

An annual herb with minute axillary flowers; July-August. In cultivated fields and as garden weed. (Gupta 654)

Acalypha indica Linn.

An annual herb with flowers in lax axillary elongate spikes. Common garden weed in the area. (Gupta 655)

***Acalypha godsefiana** Mast.

Shrub with green leaves, margin with cream colour. (Gupta 444, 488)

Urticaceae

Cannabis sativa Linn.

Undershrub with greenish-white flowers. May-June. (Gupta 632)

Pouzolzia pentandra Benn.

Perennial herb with cream-coloured flowers in clusters. August-September. (Gupta 493)

Morus alba Linn.

Small tree with flowers on short ovoid spikes. February. (Gupta 451)

Ceratophyllaceae

Ceratophyllum demersum Linn.

A submerged aquatic herb. Common in the tanks and in still water.

Hydrocharitaceae

Hydrilla verticillata Royle

Slender aquatic herb with small flowers in running or still water. (Gupta 363)

Vallisneria spiralis Linn.

Submerged stemless herb, common. (Gupta 40D)

Amaryllidaceae

Agave sp.

A perennial, commonly planted on the borders of the gardens and fields throughout the district. The species could not be identified due to the absence of flowers. It seems that there is more than one species cultivated in the area and which now have naturalised completely.

Furcraea gigantea Vent.

A perennial, often grown as a hedge plant in the area and sometimes occurs on the sides of the railway lines.

Liliaceae

Asparagus racemosus Willd.

Scandent spinous undershrub with fragrant flowers. September-October. (Gupta 190, 314, 422)

Gloriosa superba Linn.

Herbaceous climber with scarlet flower. June-October. (Gupta 634)

Asphodelus tenuifolius Cav.

Annual herb with white flowers. December-February. (Gupta 161)

Pontenderiaceae

Eichhornia crassipes Solms.

Aquatic herb. Flowers blue. March-July. Common in pools and puddles. (Gupta 431)

Commelinaceae

Commelina nudiflora Linn.

Diffuse annual with dark blue flowers. August-September. (Gupta 415)

Commelina benghalensis Linn.

Dichotomously branched annual with blue flowers. August-September. (Gupta 418)

Palmae

Phoenix sylvestris Roxb.

Tall palm. Flowering in December-January.

Phoenix humilis Royle

Shrub with scattered leaves. Flowering during December-January.

Typhaceae

Typha elephantina Roxb.

Tall bulrush with broad 3-gonous leaves above sheath. Common in pools and puddles. (Gupta 635)

Typha angustifolia Sibth. & Sm.

A tall marshy herb. Flowers in cylindric spikes, male and female often much separated. (Gupta 656)

Aroideae

Colocasia antiquorum Schott.

Herb with a thick corm and ovate leaves, having broad triangular basal sinus. Often cultivated for the leaves and for the corms that are edible.

Lemnaceae

Spirodela polyrrhiza Schleid.

A minute aquatic herb with several roots. Fronds dark green above usually purple beneath. Commonly growing with *Azolla pinnata* R. Br. in the tanks. (Gupta 657)

Wolffia arrhiza Wimm.

A minute aquatic herb, smallest of the flowering plants. Commonly covering the water of the ponds like a green scum.

Alismaceae

Sagittaria sagitifolia Linn.

An aquatic perennial with sagittate leaves. Flowers white. Commonly seen near the field channels. (Gupta 659)

Naiadaceae

Potamogeton pectinatus Linn.

Aquatic herb. Flowers : October-March. (Gupta 636)

Zannichella palustris Linn.

Aquatic slender herb with minute flowers. (Gupta 637)

Cyperaceae

Cyperus rotundus Linn. (Gupta 401)

Kyllinga triceps Rottb. (Gupta 639)

Scirpus maritimus Linn. (Gupta 640)

Scirpus lacustris Linn. (Gupta 91D)

Fimbristylis polytrichoides Vahl. (Gupta 44D)

Eleocharis spiralis R. Br. (Gupta 165)

Gramineae

Sporobolus diander Beauv. (Gupta 409)

Sporobolus commutatus Kunth. (Gupta 369)

Setaria verticillata Beauv. (Gupta 388, 396, 399, 463 C)

Setaria glauca Beauv. (Gupta 394, 397, 418, 430D)

Themeda triandra Forsk. (Gupta 391, 400)

Sorghum halepense Pers. (Gupta 448)

Arundo donax Linn. (Gupta 404, 442B)

Eragrostris tenella Beauv. ex R. & S. (Gupta 456A)

Eragrostis pilosa Beauv. (Gupta 390, 393, 395, 398, 411)

Eragrostis major Host. (Gupta 373)

Eragrostis willdenoviana Nees. (Gupta 193)

Oplismenus burmannii Beauv. (Gupta 403A, 467A & B)

Chloris incompleta Roth. (Gupta 441A)

Vetiveria zizanioides (Linn.) Nash. (Gupta 384, 420)

Amphilophis pertusa Willd. (Gupta 412)

Apluda mutica Linn. (*Apluda mutica* var. *aristata* (L.) (Pilger) Hack). (Gupta 27, 374)

Apluda varia Hack. (Gupta 392, 402)

Polypogon monospeliensis (L.) Desf. (Gupta 375, 381)

Panicum flavidum Retz. (*Paspalidium flavidum* A. Camus). (Gupta 383)

Thysanolaema maxima Kuntze. (Gupta 161, 385, 389)

Arundinella leptochloa (Nees ex Steud.) Hk.f. (*A. lawsonii* Hk.f.). (Gupta 386)

Cenchrus ciliaris Linn. (Gupta 387)

Desmostachya bipinnata (Linn.) Stapf. (Gupta 371)

Perotis indica (L.) O.Ktze. (*P. latifolia*). (Gupta 55D, 376, 377, 378)

Echinochloa colonum (L.) Link. (Gupta 379)

Tragus biflorus (Roxb.) Schult.

Sporobolus tremulus (Willd.) Kunth. (Gupta 78D)

Phalaris minor Retz. (Gupta 62)

Cynodon dactylon Pers.

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Obituary

SIR REGINALD SPENCE

We sorrowfully record the breaking of another link with the past by the death in England last September of Sir Reginald Spence.

Born in 1880, the son of Robert Spence of Bickley, Kent, young Spence came out to Bombay in 1901 as an assistant in the firm of Phipson & Co. From the very beginning of the Society, Phipsons have been closely associated with it. Following this tradition Spence took an active interest in the Society's welfare and served as its Honorary Secretary from 1920 to 1933, during which period the Society extended its activities in several fields. Spence's genial personality won him many friends and the esteem in which he was held by the public and the Government was of immense value to the Society. The negotiations begun by his predecessors for the transfer to the Government of Bombay of the financial responsibility for the housing and proper care of the Society's collections were completed by him, and the detailed plans for the beautiful new Natural History wing of the Prince of Wales Museum, Bombay, were drawn up before he left India, though he was not here to see them actually carried out.

From 1907 to 1933 Spence was one of the editors of the *Journal*. Towards the end, owing to the increasing demands made on his time by business and social work, he had to leave much of the actual editing to his colleagues, but he took an unremitting interest in the *Journal* and guided its general policy throughout the period. Outstanding contributions to the *Journal*, both written jointly with S. H. Prater, were 'The Fish Supply of the West Coast of India' (**34**: 973-991, **35** : 77-88) and 'Game Fishes of Bombay, the Deccan and the Neighbouring Districts of the Bombay Presidency' (**36** : 29-66).

Spence was as public-spirited as he was sociable and, among his many activities outside business and the Society, he found time to represent the non-official Europeans of Bombay for several years at first in the General Legislative Assembly, then in the Central Council of State, and finally in the Bombay Legislature. His public services were fittingly rewarded in 1926 by the conferment of a knighthood.

Retiring in 1934, Sir Reginald settled in Blackboys, Sussex, where for many years he continued to take part in public affairs.

With his death the Society loses one of its oldest members—one who was actively associated with the promotion of its welfare and development in the 'twenties.

EDITORS

Reviews

1. BIRDS OF CEYLON. Book 4. By W. W. A. Phillips. Pp. 50 (18.5×12.5 cm.). With 20 coloured plates, 6 photographs, and a coloured map. Colombo, 1961. The Associated Newspapers of Ceylon Ltd. Price Rs. 8.50.

This is the fourth of a series of books written by the author on the birds of Ceylon. The first dealt with the familiar birds of the garden, the second with the birds of the swamps and tanks, the third with the birds of the highlands, and this deals with the birds of the Ruhuna National Park. With the completion of this book the author has covered the 409 different species and subspecies of birds known to exist in Ceylon either as residents or migrants.

The Ruhuna National Park on the south-eastern coastal region of Ceylon contains about 200 species of birds. All these have been listed by the author at the end of the book, and they are sensibly arranged in different groups, e.g. Small Waders and Plovers; Falcons, Eagles, Hawks, Kites; Large Wading-Birds, etc. From this list one gets a very good idea of the types of bird that can be found in this area. In this volume the author has described 25 of the more prominent birds that are seen in this park. There are six good black-and-white photographs by the author and 20 coloured plates by Mrs. G. L. Lushington. Though Mrs. Lushington is apparently an experienced and competent painter, the drawings and printing of the plates in this volume are far from satisfactory. The one illustrating the Brahminy Kite and the Whitebellied Sea-Eagle is so bad that it should not have found a place in this book.

Any book dealing with the birds of Ceylon has a special interest for the birdlover in India. W. W. A. Phillips seems to have modelled his work on that of Sálim Ali, for this book has the same general scheme as THE BOOK OF INDIAN BIRDS. There is a coloured illustration for every bird described, and in 300 words you find an account of a species and information about nesting habits, distribution, song, food, and general behaviour. The author writes from his own personal observations and whatever he has to say holds our interest.

The majority of the birds of Ceylon are just minor variations of the kinds we have here, and when going through this book one has to remind oneself often that the book is not dealing with the birds of our country.

It is curious, that some of the birds described, though belonging to the same species and subspecies as those of India, appear to have a different type of call, and sing a different tune. For instance, the Whitespotted Fantail Flycatcher in India has a song consisting of 12 to 13 notes. The author says that in the Ruhuna Park in Ceylon these birds have a song of only 7-8 notes. Again the Indian Stone Curlew's call is a distinct *pick pick pick pika*. We heard this bird nightly in Saurashtra during September. But the call of the same bird in Ceylon has been rendered by Mr. Phillips as *whe whe whe whe whew whew whew whew*. In the case of the Blackbellied Finch-Lark, however, whose call is so well described as *jingly jingly jingly Eeee*, there is close correspondence between the birds here and those in Ceylon. This is a useful little book to have in one's bird library.

ZAFAR FUTEHALLY

2. UNDER THE BANYAN TREE. By Kála Teetur. Pp. 69 (25×18.5 cm.). Numerous line illustrations. Cape Town, Union of South Africa, 1961. Cape Times Limited.

This is a slim volume of reminiscences of small game shooting in the plains of northern India.

The actual identity of the author is covered by the pen name 'Kála Teetur', but the text reveals him to be a keen and experienced shikari, a good naturalist, and obviously British. He has an eye that lets very little go unobserved, and here lies much of the book's charm. Fortunately it does not fall into the class of shikar books which concern themselves exclusively with killing and attempts thereat. The good shikari sees a lot more than what he shoots at. In a shikar outing 'Kála Teetur' observes and comments on the plants and the soil, the people and their ways, the villages and the structure of the houses. Then there are amusing accounts of the elaborate staff work necessary for arranging the commissariat, and gathering suitable personnel, factors which are so necessary for a well-planned and enjoyable shoot.

The book is given its title UNDER THE BANYAN TREE in token of gratitude to and appreciation of that remarkable tree, which so often must have afforded the solace of coolth and shade to the shikari parched and weary after a hard morning's shoot in the open plains.

The initial chapter 'Introducing the Tree' draws a brief character sketch of the common trees of the plains and dwells at length on the banyan, and the amazing variety of creatures that gather under it for shade and sustenance. The subsequent chapters describe typical outings throughout the shooting season, starting from the opening shoot immediately after the rains and ending with the warm and dusty excursion well on in March. The narrative obviously does not recount events as they actually occurred, but each chapter is put together from long and varied experience to make a composite picture so typical that one feels that one has had just such a shoot somewhere sometime.

I think I have made it clear that this is not a book of instructions on good shooting. It attempts and succeeds in bringing back the sights and scenes and the events which the author and presumably his readers have enjoyed so intensely. To the middle-aged whose capacity for strenuous shooting is on the wane, these reminiscences of days when both vigour and game seemed inexhaustible are particularly enjoyable. Strangely, in memory, the inevitable fatigue and discomfort of a shoot seem vague and unreal, but a difficult right and left brought off long ago and good companionship enjoyed are still vividly exhilarating. The four middle chapters of the book are devoted to accounts of 'The Christmas Shoot'—that extremely improbable ritual with which the Nativity came to be celebrated in Anglo-India. Strangely the institution of the Christmas Shoot appears to have taken firm root in our native soil, and has been adopted reverently by the keen Indian sportsman. He annually hears that strange clinking staccato that intrudes on the pre-dawn stillness of a reedy jheel in the early hours of Christmas morning. It is the chattering of his teeth as he stands thigh deep in mud and icy water waiting for first light. Not even mad dogs! . . . but never mind that. As I have just remarked the memory of that numbing chill brings no extra twinge to the stiff rheumatic knees, but the old heart beats faster as one reads: 'A single shot rings out at the farthest end, sounding flat and very distant . . . Immediately there is a muffled roar like the approach of an express train. In a black cloud a vast swarm of duck and teal rise from the distant horizon . . .'

'There are two more distant shots and then two more in rapid fire. The shooting at the far end settles down to a steady barrage. The birds begin to break up into small parties flying to and fro. For the keen duck-shooting man this is his finest hour.'

D.J.P.

3. A BIOLOGY OF CRUSTACEA. By J. Green. Pp. xv+180. With four plates and 58 text-figures. London, 1961. H.F. & G. Witherby Ltd. Price 30*s*.

Compared to the voluminous literature on insects, that on another important group among the arthropods, viz. the Crustacea, is sparse. Carcinologists will, therefore, welcome this recent addition to our knowledge of Crustacea, where, in a concise form, the author has given a general account of various important aspects of their study.

In the opening chapter, he has given the terminology and a brief morphological account of different animals and their position in evolution. He then goes on to a more elaborate description of the mechanism of, and adaptations to, filter feeding.

A good deal of space in the chapter on blood and circulation is devoted to that in Daphnia. The nature of pigments, and the mechanism of colour change and its nervous control are well treated. In the fifth chapter, an account of the interesting phenomenon of ecdysis and the inter-relationship of the moult-inducing and moult-inhibiting hormones is combined with descriptions of the various larval stages.

The reactions to environmental changes with reference to light, sound, smell, gravity, humidity, etc., which together constitute behaviour are discussed. The latter part of the book deals with parasitic forms, distribution in space, and the impact of these animals on man.

In a work of this size, it is to be expected that several important topics have had to be excluded. The author has restricted his studies to the exterior of the animal. Even then, some topics such as osmotic regulation, terrestrial adaptations, autotomy and regeneration, etc. are left out. However, the author has clearly explained his choice of material for inclusion in the preface.

This book, written in simple language, will serve to stimulate the interest of those who desire to have general information on Crustacea available in one place. Lists of references at the end of each chapter provide information to those who wish to make a further study.

B.F.C.

4. ORCHIDS: THEIR BOTANY AND CULTURE. By Alex. D. Hawkes. Pp. xii+297 (23×15 cm.). Coloured frontispiece and several black-and-white photographs and line-drawings. London, 1961. Peter Owen Limited. Price 45*s*.

The author of this comprehensive little handbook on Orchids is well qualified for the task, being the editor among other horticultural journals of *The Orchid Journal* and *The Orchid Weekly*, and having a working acquaintance with orchids extending over more than twenty years.

The book is written in four parts. The first gives the reader general information on orchids: what are orchids?; where are they found? (how many of us know that they come from such diverse places as the 'frigid dales of Alaska' and the 'parched sandy deserts of Australia and Africa'?); their colours, sizes, and forms (sizes may vary from an overall height of less than a quarter of an inch to more than 20 ft.); how they grow; their economic importance (*Vanilla planifolia* was the original source of commercial vanilla extract, and various orchids have supplied vegetables, a beverage made after the fashion of tea, medicines, love philtres, glue, and material for weaving and basketry work, and the pseudobulbs have been fashioned into bracelets and even into horns or trumpets for use in special religious ceremonies); the history of early orchid cultivation (it is encouraging to the beginner to realise that the stronger orchids are able to live through considerable mishandling). The second part deals with the culture of orchids, and gives detailed instructions which the beginner as well as the expert will find useful. An interesting section is that dealing with orchids as plants to grow in the house—flowering orchids will be a welcome change from the Money Plant, which is so popular with Bombay residents. Part III begins with a list for beginners of easily grown orchids. A list of the principal cultivated orchids follows—about 200 species arranged in their respective genera. The list is alphabetical, so that the orchid you are searching for is readily found. General descriptions of the genera and species are given, along with notes as to where they come from and instructions about their culture. Several of the species come from the Himalayas, Assam, Burma, Ceylon, Malaya, or some other place in SE. Asia, and should be available to the orchid enthusiast in India. One longs for a similar book dealing with Indian orchids generally. However, the culture notes, even if they relate to different species, will suggest various lines of treatment, one or more or a combination of which may be found suitable. Part IV is for the more advanced orchid grower, and deals with hybrids and hybridization.

The correct pronunciation of all the generic and specific names is indicated, and a glossary explains the meanings of the technical terms used. The book is profusely illustrated with one colour plate and several black-and-white photographs and line drawings. A comprehensive index finishes this very welcome handbook.

D.E.R.

5. GNETUM. By P. Maheshwari and Vimla Vasil. Pp. xii+142 (24×16 cm.). 2 photographs in black-and-white and 85 maps and diagrams. New Delhi, 1961. Council of Scientific and Industrial Research. Price Rs. 20 or 40*s*.

This is the first in a series of about thirty Botanical monographs to be published by the Council of Scientific and Industrial Research, India, with the object, as stated by Prof. M. S. Thacker in the foreword, of bringing together all the information, at present scattered in numerous scientific periodicals, with a view to stimulate further research and to provide much helpful material for teachers and students of Botany in India. There is no doubt that this very well-illustrated treatise prepared by an outstanding botanist ably assisted by very careful research workers will fulfil a long-felt need of many a teacher in India and abroad.

In this monograph the authors present the distribution of various species very clearly with the help of maps taken, with due acknowledgement, from previous workers. The morphology, anatomy, and embryology—particularly of *Gnetum gnemon* and *G. ula*—are presented in full detail, and supported with very good illustrations. Previous work on these and other species from S. America and W. Africa is compared and discussed.

It might appear odd that the Delhi studies could not verify the chromosome number in the two species on which extensive and careful work was carried out. As often happens in such studies, suitable material may not have been available to the authors for this purpose. It is also rather intriguing why the taxonomy of *Gnetum* should have missed inclusion in the text. Photographs or figures of the Indian species would have enhanced the value of this monograph considerably as they are not available in Bharadwaja's work. An inquisitive mind will however find the extensive list of literature appended at the end very helpful.

The chapter on relationships gives a scholarly and frank appraisal of the situation as it obtains at present and ends with the statement that *Gnetum* remains largely a phylogenetic puzzle. This interesting genus is Gymnospermous but possesses some strong Angiospermic features. It is to be hoped that further work will be carried out on other species of *Gnetum* and on allied genera of this interesting group of plants by this active school of phytomorphology to solve this puzzle.

The quality of this monograph will encourage other workers to carry out critical work on many other facets of Indian botany. The best feature of this monograph is the excellence of its production, and the clarity of the photographs, diagrams, and other figures. It is hoped that the monographs that follow will maintain the same standard of scholarship and production.

P. V. BOLE

6. ATLAS OF AVIAN HEMATOLOGY. BY Alfred M. Lucas and Casimir Jamroz. Pp. vi+271 (26×20 cm.). 413 figures in colour or monochrome. Washington, 1961. United States Department of Agriculture. *Agriculture Monograph* 25. Price $4.

The ATLAS is the first of a series of publications designed to provide the basic histology and anatomy of the fowl.

The descriptive material, profusely illustrated, is presented in seven chapters. The first chapter outlines the methods of study followed by different workers, and makes appropriate reference to the necessity of employing standard criteria for the diagnosis of the cell type. The second and most extensive chapter gives an exhaustive account of the cells in the circulating blood of the hatched chicken, and is illustrated throughout with an able delineation of cell lineage and morphogenesis. The variations in morphological features due to artefacts in technique are given due emphasis. The comments on haemokonia and serum granules are unexceptionable. The third chapter deals with the cells in the circulating blood of the embryo. Blood cells from various haematopoietic organs of the embryo are described in the fourth chapter. Blood cells from the bone marrow of the hatched chicken are detailed in the fifth chapter. Blood cells of other avian species with particular reference to their difference from the blood cells of the chicken are reviewed in the sixth chapter. Standard techniques for the collection of blood, for staining blood cells, and cytometric methods are clearly described in the seventh chapter. Lastly a useful list of bibliography has been appended.

The illustrations are remarkable for their originality, precision, and clarity. As an up-to-date account of avian haematology, the book is indispensable to the research worker. As providing a ready reference to the veterinarian for the appearance of the normal cell types and their developmental stages, it will help in the fight against disease. It is therefore very good value for the money.

J. B. CHATTERJEA

ADDITIONS TO THE SOCIETY'S LIBRARY UP TO 30TH SEPTEMBER 1961

The following books have been added to the Society's library since August 1959:

Abercrombie, M., Hickman, C. J., and Johnson, M. L.: A DICTIONARY OF BIOLOGY. Penguin Books Ltd., Harmondsworth, 1951. (Presented by Col. R. W. Burton)

Ali, Sálim: THE BIRDS OF GUJARAT. Gujarat Research Society, Bombay, 1956. (Presented by Gujarat Research Society)

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Allen, Hugh: THE LONELY TIGER. Faber & Faber Ltd., London, 1960. (Review copy)

Ary, S., and Gregory, M.: THE OXFORD BOOK OF WILD FLOWERS. Oxford University Press, London, 1960. (Review copy)

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Bowley, A. L.: ELEMENTS OF STATISTICS. London School of Economics and Political Science, London, 1926. (Presented by Faiz S. B. Tyabji)

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Gamble, J. S.: A MANUAL OF INDIAN TIMBERS. Sampson Low, Marston & Co. Ltd., London, 1902. (Presented by Col. R. W. Burton)

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Miscellaneous Notes

1. MUTUAL ASSISTANCE BETWEEN MOTHER LANGURS [*PRESBYTIS ENTELLUS* (DUFRESNE)]

On 10 February 1960 at Jaipur I was watching a small troop of Langurs, *Presbytis entellus* (Dufresne), consisting of one full-grown male, five full-grown females, and five babies. I was surprised to see that one of the females (No. 1) was carrying two babies. The troop settled on the roof of a near-by house and one of the two babies was passed on to another female (No. 2), who immediately suckled it. The langurs were disturbed by the occupants of the house, whereupon female No. 1 took the baby from female No. 2 and scampered away with both the babies clinging to her breast. I noticed that female No. 2 ran on three legs; the left forelimb was pressed against her breast and appeared to be badly injured. The troop again came to rest and the young one immediately came to its real mother and started sucking. This 'handing over' and 'taking over' was observed several times in the course of two and a half hours. The other three females took no part in looking after the baby.

DEPARTMENT OF ZOOLOGY,
MAHARAJA'S COLLEGE,
JAIPUR,
August 10, 1960.

ISHWAR PRAKASH

2. THE PRESENT STATUS OF THE CARACAL (*FELIS CARACAL* SCHREBER)

Sen (*J. Bombay nat. Hist. Soc.* **56** : 317) and Srivastava (ibid. **57** : 214) have reported observing the caracal at Hazaribagh (Bihar), Sariska (Rajasthan), and Saharanpur (Uttar Pradesh). While surveying the Rajasthan desert for mammal studies in 1954, I saw a caracal skin with a *Sansi* (local tribesman) who refused to sell it at any price. He said that he had captured and killed it at Bikaner but, during our study, we did not collect any specimen of caracal from the Bikaner region. Adams (1899, WESTERN RAJPUTANA STATES: 170, Taylor & Francis) states 'The red lynx (*Felis caracal*) . . . are fairly numerous in these states'. Pocock (1939, FAUNA OF BRITISH INDIA, MAMMALIA **1** : 309) speaks of its rarity and suggests that in all probability it will follow the fate of the Cheetah, *Acinonyx jubatus*, unless strict measures can be enforced for its protection. One of my shikari friends tells me that caracal are still found in fair numbers in the Bundi region of Rajasthan.

DEPARTMENT OF ZOOLOGY,
MAHARAJA'S COLLEGE,
JAIPUR,
August 10, 1960.

ISHWAR PRAKASH

3. THE SENSES OF THE TIGER

On a former occasion (1951, *J. Bombay nat. Hist. Soc.* **49** : 732) the present writer reported an instance of a tiger winding the presence of a man at 50 yards. Here is a personal experience which affords evidence of the tiger using his nose, and of his remarkable keenness of vision.

On the morning of 22 March 1928 in the Central Provinces it was found that a large tiger had killed my tethered buffalo calf, broken the wire rope, and taken the kill about 200 yards, the latter part through lantana. The only available tree was leafless. By 2.30 p.m. a chair-machan was fixed on it, and screened all round and below with leafy branches. Towards dusk the tiger uttered a 'woof' to scare any intruder. Then came the shrill alarm call of a cock junglefowl. Next I heard him using his nose—loud sniffs. He came to my left and below me. More sniffs. Then he went away and began a 'grumbling' approach along the drag of the kill, through the lantana. He was hungry. Now arrived the last glimmer of daylight.

I had tethered the kill fore and aft so as to afford a sideways shot. The electric-light box was suitably placed. My loophole was screened by a khaki handkerchief tied at three corners with the lower right hand corner secured by a large pin readily removable. The arms of the chair, the shooting-bar, and the footrest were all padded with khaki woollen putties. The seat of the chair had a leather cushion. No movement of mine could make any sound. There was no breath of air. Wanting to watch the tiger, I lifted a very small corner of the pinned handkerchief. He must have had his eyes lifted upwards as he crept along, for he instantly uttered a frightened 'woof' and crashed away on his back tracks like a scalded cat. And that was the last of him.

He must have had some previous sharp experience, and perhaps been fired at and, maybe, slightly wounded.

C/O LLOYDS BANK LTD.,
39, PICCADILLY,
LONDON W. 1,
October 31, 1961.

R. W. BURTON,
LT.-COL., I.A. (RETD.)

4. NOTE ON A REPUTED SKULL OF *NEMORHAEDUS CRANBROOKI*

(*With two text-figures*)

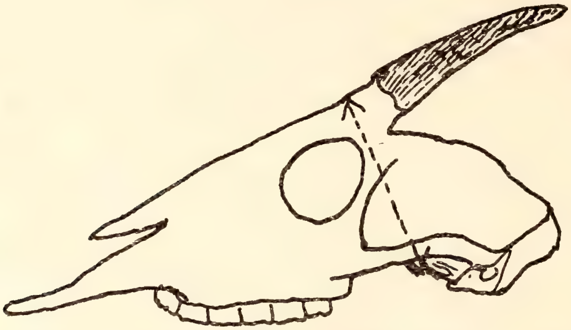
It is only recently (Hayman, 1961) that the existence of a bright red goral from the north-east frontier region of Assam and from extreme north Burma has been recognised and the name *Nemorhaedus cranbrooki* proposed for it. The material described consisted of a complete skin (the type) from the Adung Valley of Upper Burma, collected in 1931 by Lord Cranbrook, and a rug made of pieces of skin from animals collected in the Mishmi Hills of Assam in 1922 by Mr. H. L. Cooper. This material is in the collection of the British Museum (Natural History). Reports were also quoted from the literature as far back as 1912 indicating that the goral of this region was very distinct in colour. A still earlier reference (Blyth, 1863) indicates that a red goral from Assam was known nearly a hundred years ago.

Unfortunately, at the time of description of *Nemorhaedus cranbrooki* (1961, *Proc. zool. Soc. Lond.* **136** : 319) no skull was available for description. The type was originally complete with skull, but only the mandible could be traced. Although this gave a valuable indication of the age of the animal and the probable proportions of the missing skull to which it belonged, an obvious gap in the description remained to be filled.

The skins forming the rug presented to the British Museum (Natural History) by Mr. H. L. Cooper in 1960 were without skulls, but I was informed by Mr. Cooper that at the time of collection a more or less complete skin and skull of this animal was sent to the Bombay Natural History Society. As a result of enquiries I have made recently, it appears that this skin can no longer be traced, but that the Society has in its collection the skull of a goral from the Mishmi Hills entered in its records as having been received in 1925 from Mr. Cooper. I am greatly indebted to the Honorary Secretary, Mr. Humayun Abdulali, for making this skull immediately available to me in London for examination. Detailed comparison of this skull, B.N.H.S. No. 5091, with all other goral skulls available has disclosed that in certain details of structure it can be separated at once from all other known forms. The skull is unfortunately incomplete: the nasal and premaxillary bones are missing, the horns are missing, the back of the cranium has been cut away, and the first two premolars on each side have been lost. The remaining teeth show that the animal was adult but not aged. Its general condition and colour suggest that it may have been acquired originally from a Mishmi hunter or picked up in a Mishmi village, since it appears to have been smoke-dried, and the cutting away of the back of the cranium may well have been done to extract the brain for food.

In its general features the skull is undoubtedly that of a moderate-sized goral. It is in the conformation of the anterior part of the brain case that it differs from all other goral skulls seen. The plane of the horn cores is only very slightly elevated above the plane of the frontal bones forming the forehead; in most other goral skulls there is a distinct angle. The brain case shows a comparative shallowness best demonstrated by the following measurement. The total depth of the post-orbital part of the cranium measured from the surface of the frontal bone at the upper base of the horn core to the surface of the glenoid fossa is 54.5 mm. In a *Nemorhaedus goral hodgsoni* skull, B.M. No. 21.5.1.45, of the same approximate age, of almost identical overall dimensions, and with an identical maxillary tooth row length, the corresponding figure is 60. The reduction in depth of the cranium in the Mishmi skull is quite obvious, and in all larger or older goral skulls examined the difference in this part of the skull is still more obvious, as is also the generally greater elevation of the plane of the horns. (Text-fig. 1)

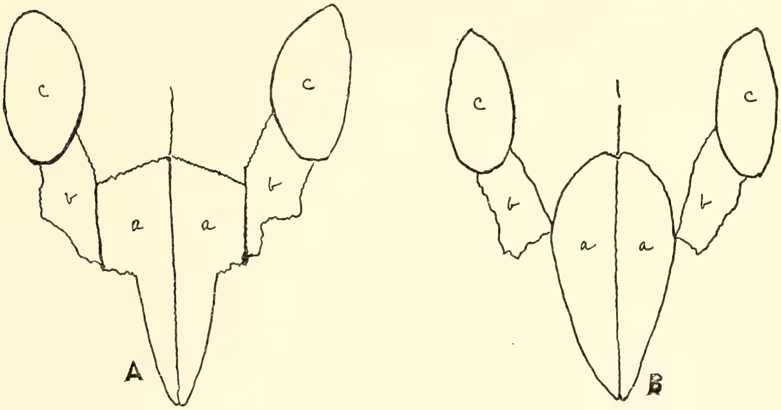
The distinctions outlined above leave me in little doubt that the skull from the Mishmi Hills represents *Nemorhaedus cranbrooki.* Its posterior reduction in overall depth is paralleled by the comparatively shallow depth of the mandible of the type. The following skull measurements of skull No. 5091 may be recorded here with, in parentheses, the corresponding figures for the *N. g. hodgsoni* skull, B.M. No. 21.5.1.45. Maxillary tooth row at alveoli 67 (67); palatal breadth outside $m^1 - m^1$ 55 (56.5); zygomatic breadth 83.8 (83.5); anterior edge of orbit to anterior point of maxilla 92 (92); length of horn core from lower base 62 (50).



Text-fig. 1. Lateral view of goral skull to show measurement (dotted line) used in comparison. × $\frac{3}{8}$.

While making these comparisons, a hitherto undescribed feature of the skull of the type and only known specimen of *Nemorhaedus baileyi* Pocock from south-east Tibet was noted. Pocock gave no details of the skull, and based his description of the animal as a distinct species entirely on external characters. These do not indicate any close relationship to *N. cranbrooki* although the latter is geographically not distant. The distinctive feature of the skull of *N. baileyi*, separating it clearly from all other goral skulls seen, is the form of the nasal bones and their relationship to the adjoining lachrymal bones. In all skulls of other gorals examined the posterior part of the outer margin of the nasal bone curves sharply forward to make contact laterally with the upper edge of the lachrymal bone only at or about the anterior upper angle of that bone, close to its junction with the upper edge of the maxilla. From that point the outer edge of the nasal bone tapers forward evenly to its apex. Even though the nasal bones are missing from the Mishmi Hills skull here believed to represent *N. cranbrooki*, it is obvious from the position of the sutures in relation to the lachrymals that the same pattern occurs. (Text-fig. 2, B).

On the other hand, in the skull of *N. baileyi* the posterior part of the outer edge of each nasal, instead of curving forward to make limited contact only with the anterior edge of the lachrymal, extends laterally to meet the upper edge of the lachrymal about half way along its length, i.e. about half way between the anterior margin of the orbit and the anterior upper angle of the lachrymal. Thus the outer edge of the posterior part of the nasal bone has a long contact, about 20 mm., with the upper edge of the lachrymal and the adjoining upper edge of the maxilla. The outer edge of the nasal, instead of then tapering forward evenly to the apex as in all other gorals, forms a sharp inward angle before narrowing abruptly and then tapering forward evenly to the apex (Text-fig. 2, A). In addition the greatest breadth of the combined nasals, 38 mm. measured across their lateral junction with the lachrymals, is greater than in any other skull seen and very much greater than in most.



Text-fig. 2. Nasals and lachrymals of (A) *Nemorhaedus baileyi*, Type × ½ and (B) *N. goral* and *N. cranbrooki*, × ½. (a) Nasals ; (b) Lachrymals ; (c) Orbits.

This modification of the form of the nasals, taken together with the distinctive external characters of the animal, leads to the suggestion that *N. baileyi* may eventually have to be recognised as a distinct species, and not regarded as a local subspecies of *N. goral* as in current classification.

I may here put on record that although the skull of the type of *N. cranbrooki* has remained untraced, one of the horns, fully labelled, has come to light recently. It is similar in form to those of other small gorals, is rather slender, and measures 4⅜ inches on the front curve, 4 inches in a straight line.

Finally, I would appeal through the pages of this journal for sportsmen, officials, or travellers who may have the opportunity of obtaining further specimens of the red goral from the Mishmi Hills or north Burma, or from any adjoining hill territories to send complete specimens, skins with skulls, with exact data of locality, to the

Bombay Natural History Society in order that the characters and true relationships of these little-known animals may be further studied.

British Museum (Natural History),
Cromwell Road,
London, S.W. 7,
September 15, 1961.

R. W. HAYMAN

5. THE DUGONG, *DUGONG DUGON* (MÜLLER), AT BOMBAY; AN INCORRECT RECORD

Dr. C. V. Kulkarni, Director of Fisheries, Maharashtra State, has drawn our attention to the statement at page 137 of Volume I of THE GAZETTEER OF BOMBAY CITY AND ISLAND, published in 1909, that the dead body of a dugong or sea-cow drifted ashore just opposite Colaba Church, on Bombay Island, in the year 1849. A foot-note in the GAZETTEER indicates that this statement is based on *The Times of India* dated 13-5-1849 and 16-5-1849.

The Times of India in those days went under the appellation of *The Bombay Times and Journal of Commerce* and appeared twice a week. Through the courtesy of *The Times of India* we were permitted to examine the files of old issues. There was no issue dated 13-5-1849, but the issue of 16-5-1849 carries a report that, in the forenoon of the previous Sunday (13-5-1849), 'a tolerably large species of whale-bone whale' drifted ashore on the rocks opposite to Colaba Church. The report goes on to mention that 'recently' some people in Ceylon had seen 'a *burra-muchee*, which was later identified as a dugong'. From the coincidence of the dates and the resemblances between the two accounts it appears that a mistake has been made and that the statement in the GAZETTEER, so far overlooked and unquoted, has no basis in fact. This is an interesting example of the necessity for careful scrutiny of assertions of fact, even in official records.

Bombay Natural History Society,
91, Walkeshwar Road,
Bombay 6,
November 15, 1961.

EDITORS

6. ON THE INDIAN GREAT REED WARBLER, *ACROCEPHALUS STENTOREUS* (HEMPRICH & EHRENBERG) BREEDING IN KERALA

While collecting data on birds nesting in the reed beds of Vembanad Lake in Kuttanad area in Kerala State, I was puzzled by the identity of a pair of birds which I frequently heard calling out from the reeds but was unable to see. Careful search in a boat revealed three nests with eggs. The general characters and plumage coloration as noted in the field pointed to one of two possibilities, either the Thickbilled Warbler (*Phragamaticola aëdon*) or the Indian Great Reed Warbler (*Acrocephalus stentoreus*). By collecting a specimen I determined the identity as the latter, an identification which was kindly confirmed by Dr. Sálim Ali, according to whom there is as yet no record of this bird nesting in Travancore (1953, THE BIRDS OF TRAVANCORE AND COCHIN).

The three nests with eggs were discovered on 17th August 1961. Two empty nests, similar in construction, appearance and location, were discovered the next day. The nests were neat, deep, massive cups, firmly slung between three to seven reed stems (*Ochlandra travancorica*) standing in 5½ to 6 ft. depth of water. They were made of dead reed stalks and leaves with the inside lined with soft tender reed leaves and were placed 2 to 3½ ft. above the surface of the water. The nests were within a circle about 100 ft. in diameter; the shortest distance between two nests (both with eggs) was about 10 ft. Within an area of about 100 acres searched, only these five nests were found and the birds were seen or heard only in the immediate vicinity.

Each of the three clutches consisted of three eggs, oval in shape, dirty bluish in colour, speckled with blackish brown, and without any gloss. The speckling was heavier at the broad end than at the thin end. The specimen collected had very worn plumage; the other birds seen (two more were handled) also had worn plumage and appeared to be in heavy moult.

VATTAPARAMPIL, KAINADY,
PALLOM, KERALA,
October 25, 1961.

P. V. GEORGE

[Though long believed to be only a winter visitor to peninsular India, in 1931 Sálim Ali (*J. Bombay nat. Hist. Soc.* **35** : 450) recorded that though no nests were found their behaviour left no doubt that the species nested in mangrove swamps that fringed the tidal swamps near Bombay. Subsequent observers have also seen and heard the birds in July and August. Mr. George's note records an interesting discovery. The single specimen available does not permit racial identification though *A. s. meridionalis* (Legge) is known to be resident in Ceylon.—EDS.]

7. 'THE MOULTING OF DUCK AFTER ARRIVAL IN INDIA'

On 9 November 1961 I was shooting at a large lake in Nasik District, Maharashtra, when I saw a duck swimming on the water apparently unable to fly. When I approached it by boat, it attempted to escape by diving repeatedly. Thinking it was injured, I shot it, and, upon examination, found it lacking the primaries of both wings; evidently this prevented flight. The bird in question was a female white-eyed Pochard [*Aythya nyroca* (Güldenstädt)]. There are earlier records of similarly moulting Common Teal, Shoveller, and Wigeon having been obtained in the same area and at Bharatpur, Rajasthan (*J. Bombay nat. Hist. Soc.* **42** : 443-5; **44** : 300-1).

C/O IMPERIAL CHEMICAL INDUSTRIES
(INDIA) PRVT. LTD.,
CRESCENT HOUSE, WITTET ROAD,
BALLARD ESTATE,
BOMBAY 1,
November 24, 1961.

S. CHAUDHURI

8. NOTES ON THE BIRDS OF NEPAL

I have followed with much pleasure Dr. Biswas's interesting series of articles in the *Journal* on the Birds of Nepal. The following notes are written with particular reference to the first three parts and include some fresh records collected during 1960-61. On the Pharping road, SW. of Kathmandu, there is a small jheel called Taudah. It is covered with water lilies and weeds and surrounded by grass and reeds. As it is in a cultivated area and people are always present, washing, watering cattle, or tending domestic ducks, I had not thought there would be many wild birds on it and rather neglected this area in the past. This year I found many new birds on it, and probably many of Scully's birds, not recorded since from the Valley, may have come from this area.

Podiceps ruficollis capensis Salvadori. Indian Little Grebe.

Not recorded in the Valley since Scully's day. On 21 March 1961 I found two pairs on the Taudah jheel. They were constantly uttering the peculiar whinnying cry which I have always associated with breeding birds. I remember in England watching a pair building in late February in a flooded quarry. As they collected water weed and piled it on to the nest they uttered this cry continuously. I visited the jheel again on 24 April. Only one pair was present, very wary and diving whenever one approached them. In June they had left the jheel and up-to-date (Oct.) they have not been seen there again.

Nycticorax n. nycticorax (Linn.). Night Heron.

I was quite mistaken in recording this bird as a resident in the Kathmandu Valley (*J. Bombay nat. Hist. Soc.* **48** : 719). Dr. Fleming first pointed out to me that it was certainly not here in winter and this is quite correct. This year I kept careful records. It was seen for the first time on 22 April, about 15 birds flying over the Royal Hotel at dusk. Not noticed again until the end of May when odd birds seen, also in June. Common July and August. Not noticed in September, but a single bird flew over my garden on 3 October in twilight. They used to be common standing along the side of the Rani Pokhri in the monsoon, but this year very few birds seen there. 2 birds on 19 October.

Ixobrychus cinnamomeus (Gmelin). Chestnut Bittern.

Only recorded by Biswas in the Dun of central Nepal, but one or two pairs breed regularly in the Valley near Gowkarna. They live in the rice fields during the monsoon. This year we shot a breeding male on 17 June.

Anser indicus (Latham). Barheaded Goose.

There appear to be no records for the Valley, but Colonel Roberts of the British Embassy shot one in the spring of 1959. He also reported seeing a single bird in the same area, the Manora River, just before Christmas 1960. On 10 October 1961 I saw a single bird flying over my garden. It was quite low and could be clearly seen. All these birds were solitary, and I suppose odd stragglers get separated from flocks of migrating birds and wander by chance into the Valley.

Aythya nyroca (Güldenstädt). White-eyed Pochard.

Not recorded from the Valley since Scully's time. Colonel Roberts tells me they are quite common on the lakes at Pokhara in central

Nepal in winter. This year 2 females were seen on the Rani Pokhri a small lake in Kathmandu town. They were there in the second week in May and remained for several days.

Aythya fuligula (Linn.). Tufted Duck.

In early July I was told that there were 7 of these duck on the Rani Pokhri. I went down on 15 July and saw 3 drakes and 1 duck. They sat in a little knot in the middle of the lake. They were there till 30 July when only 1 drake and 1 duck remained. On 1 August 1 drake only; on 4 August all gone and none seen since. This seems a very odd record to me. Dr. Biswas has reported them on high elevation lakes in May, so perhaps these were birds which had finished breeding early, although one would think they had hardly had time for this.

Accipiter gentilis schvedowi (Menzbier). Goshawk.

Although not recorded from the Valley since Scully's day the Goshawk is in fact tolerably common on the forested hills round the Valley. We have seen it many times on all the main ridges about 7500-8500 ft. (2300-2600 m.), but it never leaves the forest. It frequently perches on some prominent tree overlooking a little glade and no doubt watches to pounce on partridges etc., although we have never seen it do this. It does not appear to move at all with the seasons. On May 18 on the Mamche Danda a Goshawk flew into an oak very close to us. It was furiously mobbed by a pair of Jungle Crows. It is a large bird and could not possibly be confused with any other species. When perched other birds take no notice of it, but when it flies a chorus of terrified squeaks and calls accompany its passage.

Spizaëtus nipalensis nipalensis (Hodgson). Hodgson's Hawk-Eagle.

Quite a common bird, although each pair has a very large territory. One pair for the whole Sheopuri Ridge, where in spring they perform a very beautiful nuptial flight. It is then possible to approach them closely. Another pair is resident on Phulchowk, and I think a third on the Nangi Danda Ridge beyond, but this might be the Phulchowk pair. Odd single birds are often seen on Nagar Jung, perhaps young birds without territory.

Aquila chrysaëtos (Linn.). Golden Eagle.

Not uncommon on the Gandak-Kosi watershed above 9000 ft. (2800 m.) in summer. I have seen 2 adults and 1 young bird soaring over the ridge below Thare Pate. My husband watched one at 14,000 ft. (4270 m.) on the Gosainkund Lekh in May. It attacked a covey of large partridges, perhaps the Tibetan Partridge, but he was unable to identify them.

Circaëtus gallicus (Gmelin). Short-toed Eagle.

During the weekend of 14-16 April we were on the Kakani Ridge at 7000 ft. (2130 m.) and each day we saw this eagle soaring and frequently hovering along the north side of this ridge. Several times we saw it dive steeply into the Valley [which here drops abruptly to about 2000 ft. (600 m.)] but we were never able to see the end of the dive nor what it caught. On many later visits to this ridge we have not seen it again.

Falco subbuteo Linn. The Hobby.

On 22 May 1961 on the Mamche Danda (the ridge north of the hills bounding the Kathmandu Valley) we watched 3 Hobbies wheeling round the oak-covered ridge on which we were camped. They were there all day, but never seemed to catch anything but butterflies, which they ate on the wing, holding them in their claws and tearing off the wings before eating them. A few days later Dr. Fleming said he saw 5 Hobbies behaving in exactly the same way on the ridge near Kakani. Both ridges between 7500-8500 ft. (2300-2600 m.). I have often seen them in winter, but then they are usually single. I have never seen them on the hills south of the Valley.

Alectoris graeca chukar (J. E. Gray). Chukor.

Although we had constantly heard tales of Chukor on the hills round Kathmandu, we had not come across them in 12 years of searching, and were inclined to think the birds extinct in this area. However, this year we saw a covey near Kakani [7000 ft. (2130 m.)] in January, and in April my husband saw a bird calling. Dr. Fleming has since shot a bird and said they were tolerably common well east of Kathmandu, so our birds are not stragglers on the extreme eastern limit of their range as we had supposed.

Francolinus francolinus asiae Bonaparte. Black Partridge.

I am sure this bird has increased very much in numbers during the last 5 years. It is now really common on the hills round Kakani at 5-7000 ft. (1520-2130 m.). Its call is heard on all sides during May, June, July, but we have never heard it call after the beginning of August.

Ithaginis cruentus cruentus (Hardwicke). Blood Pheasant.

Common on the Gandak-Kosi watershed at 11-12,000 ft. (3350-3660 m.) in bamboo forest. They are very tame.

Grus grus (Linn.). Common Crane.

Anthropoides virgo (Linn.). Demoiselle Crane.

Both these birds are common in the Rapti Dun in winter. On 22 October my husband saw a flock migrating over the ridges beyond Kakani. He estimated the flock at about 300 birds. They flew at least 1000 ft. (300 m.) above the ridges but, although this was not necessary, they always flew directly over the passes which form the lowest point in each ridge. They flew directly south, avoiding the Kathmandu Valley and were making in a direct line for the area where we have seen them in winter. They appeared to have flown down the Trisuli Valley which leads through the main Himalayan mountains into Tibet. My husband was unable to tell to which species they belonged.

Porzana pusilla pusilla (Pallas). Baillon's Crake.

Not recorded since Scully's day. I saw one on Taudah jheel on 21 March 1961. The reed cover was very thin and I had an excellent view as it walked nervously through the grass. I was able to get within 8 feet (*c.* 2 m.) of it. It must have been on migration as it has not been seen there again.

Amaurornis phoenicurus chinensis (Boddaert). Whitebreasted Waterhen.

Common in the Rapti Dun, but seen only once in the Valley. A single bird was in the rice near the Bagmatti River and when disturbed flew over the wall of the King's Reserve at Gowkarna. 17 June 1961.

Gallinula chloropus indica Blyth. Indian Moorhen.

Very common in suitable country in the Rapti Dun, but not previously recorded from the Valley. This autumn I saw two birds on Taudah jheel on 23 September. They were still there on the 25th. On 7 October there were 5 birds. Teal and Garganey use this jheel as a resting place when migrating and on 7 October there were 77 Garganey on the jheel. The Moorhen kept together in a little cluster. The Garganey got up as we approached the water. The Moorhen did not fly with them but moved off together to the far side of the jheel.

Eupodotis bengalensis bengalensis (Gmelin). Bengal Florican.

Biswas says this bird has not been found in Nepal since Hodgson's day, but it is certainly not uncommon in the Rapti Dun in winter. It is found in the open grass country between the Rapti and Narayani rivers. I have seen them several times in December and last year had an excellent view of one quite close to us. We had seen it fly into a mustard field and failed to flush it out, when it suddenly walked out quite near us. When it crouches its camouflage is excellent and it appears to melt suddenly out of sight.

Scolopax rusticola rusticola Linn. Woodcock.

Woodcock breeds quite commonly on the Gandak-Kosi watershed. Most birds seen about 10,500-11,000 ft. (3200-3350 m.). We have found it there in early and late May and often watched it roding in the evenings. In winter it is also much commoner than I had supposed on the hills north of the Valley, where there are many small damp valleys with berberis, camellia, etc. bushes. They are found in the same place year after year.

Calidris subminutus (Midden.). Longtoed Stint.

Dr. Fleming obtained this bird on the Bagmatti in May. This autumn I have examined carefully the flocks of Temminck's Stints which congregate on a small island in the Manora River from October to April. There are usually about 30 birds there, and two or three are darker than the others and spotted above. I had thought these were birds still in breeding plumage but think now that probably one or two Longtoed Stints are often present amongst the flocks of the commoner species.

Rostratula benghalensis benghalensis (Linn.). Painted Snipe.

Not uncommon in the Rapti Dun in winter. We have seen odd ones in the Valley during the monsoon. My husband shot a male here in July and a female in November.

Burhinus oedicnemus indicus (Salvadori). Indian Stone Plover.

On 24 August 1961 we saw a pair of these birds near the Manora River. They are obviously rare stragglers to the Valley during the monsoon.

Cuculus poliocephalus poliocephalus Latham. Small Cuckoo.

This year we trekked up to the Gosainkund Lekh in late May and found this bird absolutely abundant from 8000 ft. (2450 m.) to nearly 12,000 ft. (3660 m.). A breeding male was shot at 10,500 ft. (3200 m.). They start to call much later in the year than the other cuckoos and continue calling until the end of July when most of the other cuckoos are silent. I have not heard them before the first week of May. The Cuckoo and the Himalayan Cuckoo start to call in late March and the Indian Cuckoo in the first week of April. The first two birds call till the 3rd week of June, the Indian Cuckoo till the 3rd week of July.

Coracias benghalensis benghalensis (Linn.). Indian Roller.

Although never seen in the Nepal Valley it is common in the Dun and lower hills below 3500 ft. (1060 m.). This year a bird remained for some time on Kakani Ridge [7000 ft. (2130 m.)]. This was in August during heavy monsoon weather. It spent all day quartering the ridge and roosted at night in a solitary pine tree in front of the bungalow.

Conostoma aemodium Hodgson. Great Parrotbill.

This bird is extremely local but very common in the limited area where it occurs. This is the mixed bamboo, maple, etc. forest at 11,000-12,000 ft. (3350-3660 m.) along the head of the Tādi Khola on the Gosainkund Lekh. Every naturalist who has visited that area reports seeing them. We watched them for some time this year in late May and shot one which proved to be a female near breeding. The birds were very noisy with much churring and chattering very like a *Turdoides*. They have also a characteristic note very harsh *krrarchah, krarch krachah.* I did not hear the mellow whistle described by Smythies. They keep very much to bamboo jungle, and though large clumsy birds are skilful at keeping out of sight.

Myzornis pyrrhoura Blyth. Firetailed Myzornis.

On the Gandak-Kosi watershed in late May we found a pair of these birds feeding young in the nest. This was in deep juniper forest at 12,000 ft. (3660 m.). The parents were very busy collecting insects on the trunks of junipers and they ran up the trees almost in the manner of a tree-creeper. Their bills were absolutely crammed with tiny black insects.

Callacanthis burtoni (Gould). Redbrowed Finch.

I can find no records of this bird in Nepal, and never saw it here myself till this year. On 25 March, 3 of these birds were feeding on the ground on Sheopuri at 8200 ft. (2500 m.). They were in an open glade in deep forest. When disturbed they flew up into a bush but soon returned to the feeding ground. A male shot was not in breeding condition. They were quite silent. I have not seen them again.

Leucosticte nemoricola nemoricola (Hodgson). Hodgson's Mountain Finch.

Large flocks, at least 200 birds and probably many more, wander on to the hills north of the Valley during January to early March. They keep to the open grassy hillsides with berberis and pyrus bushes.

Propyrrhula subhimachala subhimachala (Hodgson). Redheaded Rosefinch.

We found these birds tolerably common in the high level mixed forest above Pokhara in November, but had never seen them in the Kathmandu Valley until this year. On 27 March on Sheopuri at 8400 ft. (2560 m.) I watched a pair of these birds feeding on the berries of *Mahonia nipalensis*. The male was gorging on the green berries, half hidden by them and obviously under the impression that he was completely hidden for, when a cooly passed by, he froze and allowed the man almost to brush against him. I managed to creep very close and he continued feeding, sometimes turning almost upside down to pick a berry and then reversing to normal position while he ate it. He was presently joined by the female who perched lower in the bush, and also ate the berries and was equally tame. A very beautiful sight.

Carpodacus thura thura Bonaparte & Schlegel. Whitebrowed Rosefinch.

During the last week of May we found these birds very common at Thare Pate on the Gandak-Kosi watershed. They were in pairs, but the pairs kept together in loose flocks. A female shot was not in breeding condition. They were always found in *Rhododendron campanulatum*, which was still in flower between 12,000 ft. (3660 m.) and 13,000 ft. (4000 m.). The birds were rather noisy. They had a ringing call but harsh and ill-tempered in sound *cha cha cha cha cha*.

BRITISH EMBASSY,
KATHMANDU,
NEPAL,
October 19, 1961.

DESIRÉE PROUD

9. CORRECTIONS TO 'SOME NOTES ON THE BIRDS OF THE NEPAL VALLEY'

I would like to make the following corrections to my paper 'Some Notes on the Birds of the Nepal Valley' (*J. Bombay nat. Hist. Soc.* **48** : 695-719) which was based on sight records:

p. 711. *Riparia riparia:* Small Sand Martin.

This should of course be **Riparia paludicola** (Vieillot): Plain Sand Martin. I have seen birds with a faint dark band across the breast, but all shot have been *paludicola.*

p. 712. *Anthus campestris:* Tawny Pipit.

A complete mistake. I have never found this pipit here. The pipits of the Valley are as follows:

Anthus hodgsoni hodgsoni Richmond: Hodgson's Tree Pipit. Breeds on the higher hills up to at least 13,000 ft. A few pairs breed as low as 8000 ft. On 22 May 1961 I found a pair feeding young in the nest at 8000 ft. on the Mamche Danda. They winter on the hills round the Valley from 6500 to 8500 ft., but I have never found one in the Valley itself.

Anthus hodgsoni yunnanensis Uchida & Kuroda: Yunnan Tree Pipit. Abundant wintering bird in the Valley and Duns. First date this year 22 September, a single bird in my garden. Most arrive first week October. All gone by 19 April.

Anthus novaeseelandiae richardi Vieillot: Richard's Paddyfield Pipit. Winter visitor and passage migrant.

Anthus novaeseelandiae rufulus Vieillot: Paddyfield Pipit. The common breeding pipit of the Valley and up to 7000 ft. in places.

Anthus pelopus J. E. Gray: Hodgson's Pipit. Breeds commonly on the higher hills, above 11,000 ft. Very abundant at 12,000 to 13,000 ft. I have not been higher than this, so do not know to what height it goes. Winters in the Valley and Duns.

Anthus cervinus (Pallas): Redthroated Pipit. I think a passage migrant. A few are seen in the marsh round the rice fields each year in September, but I have not yet obtained a specimen and this may not be a correct identification.

Anthus (Oreocorys) sylvanus (Hodgson): Upland Pipit. Common on all the hills from 5500 to 8000 ft., but rather local.

p. 713. *Aethopyga gouldiae:* Mrs. Gould's Sunbird.

This should be **Aethopyga nipalensis** (Hodgson): Nepal Yellow-backed Sunbird.

p. 719. *Nycticorax nycticorax:* Night Heron.

This is only a monsoon visitor to the Valley.

BRITISH EMBASSY,
KATHMANDU,
NEPAL,
September 26, 1961.

DESIRÉE PROUD

10. RECOVERIES OF RINGED MIGRATORY AND RESIDENTIAL BIRDS AT HINGOLGADH, JASDAN

An Orphean Warbler *Sylvia hortensis* ringed on 27th September 1960 at Hingolgadh, Jasdan, was recaptured at the same place on 21st September 1961. Similarly, a Wryneck *Jynx torquilla* ringed on 10th October 1960 at Panelia (barely 3 miles as the crow flies from Hingolgadh) was recaptured there on 13th October 1961. These birds must have travelled many thousands of miles during the year, but they were recaptured in the same places.

There were several recoveries in Sept./Oct. 1961 of residential birds ringed in Sept./Oct. 1960. In all these cases: 5 Redvented Bulbuls, 1 Indian Robin, 1 Rufousbacked Shrike, 1 Baybacked Shrike, 1 Great Grey Shrike, no bird ringed at Panelia was recovered at Hingolgadh and *vice versa.* In fact in the case of the Great Grey Shrike, the bird was ringed on 10th October 1960 and recaptured on 13th October 1961 in the same babool tree as last year. This time it had brought along its mate too and so both now have rings.

A House Sparrow (*Passer domesticus*) was caught at Jasdan, and ringed (A 3072) and released at Hingolgadh 12 miles from Jasdan on 27th September 1960. It was recaptured at Jasdan on 6th April 1961 where it was building a nest in the same room where it had been caught in 1960.

THE PALACE,
JASDAN,
October 15, 1961.

YUVRAJ SHIVRAJKUMAR

11. NOCTURNAL 'PREDATOR' OF FRUIT OF YELLOW OLEANDER (*THEVETIA NERIIFOLIA*)

On several days in October last I found in the early mornings under some mango trees in my garden the remains of the meal which some creature of the night seemed to have eaten in the trees. Usually it consisted of green guavas with the flesh partly eaten. On six separate occasions, however, it was the fruit of the Yellow Oleander (*Thevetia neriifolia*), which is said to be highly poisonous. On four occasions a small portion of the flesh was eaten, and in the flesh that remained there were pits dug by a beak-like mouth; in one case less than half the flesh of the fruit remained; in another there was a freshly denuded seed under the tree and I could not find any trace of the flesh. Looking about near the place where the partly eaten fruit has been dropping I found ten more seeds of Yellow Oleander. There is no Yellow Oleander plant near by from which the seeds could have come; so the night feeding has probably been going on for some time. Could this be the work of a fruit-eating bat? One night at about 9.30 my daughters saw a flying fox in flight near the mango trees but it did not settle.

There are records of Yellow Oleander fruit being eaten by the Koel (M. Krishnan, 1952, *J. Bombay nat. Hist. Soc.* **50** : 943-5) and by the Grey Hornbill (K. K. Neelakantan, 1952, ibid. **51** : 738). N. L. Bor & M. B. Raizada (1954, SOME BEAUTIFUL INDIAN CLIMBERS AND SHRUBS: 195) say that 'all parts of the plant are poisonous' and A. P. Benthall (1946, THE TREES OF CALCUTTA AND ITS NEIGHBOURHOOD: 303) that 'all parts of the plant have to be used with great caution'. Both these authors expressly speak of the latex, the seeds, and the wood as poisonous, but make no special mention of the fruit. M. Krishnan (*loc. cit.*) says that the pulp of the fruit is 'known to be definitely poisonous to mammals', in which case it would be remarkable if it is a bat that has been eating the fruit. From the Editorial note to M. Krishnan's Miscellaneous Note it appears that Kirtikar & Basu (INDIAN MEDICINAL PLANTS) speak of the fruit as poisonous. Could it be that that there is a stage in the development of the fruit at which the poison is innocuous to certain animals, a fact that helps the plant to spread its seeds?

49 PALI HILL,
BANDRA,
BOMBAY 50,
November 4, 1961.

D. E. REUBEN

12. JUMPING SNAKES

I have only recently seen Mr. A. E. Butler's account of how the Russell's Viper, *Vipera russelli*, will jump to attack [*J. Bombay nat. Hist. Soc.* **55** (1) : 173].

I can state categorically that no known species of snake *deliberately* jumps off the ground to attack. But just as directly it can be stated that certain species of vipers in the act of striking do in fact *involuntarily* jump off the ground, but the jump is unintentional.

The vipers (or adders) are poisonous snakes with movable or hinged fangs which when not in use are folded back against the roof of the mouth. To get the fangs into striking position the snake has to depress the lower jaw, but this cannot be effected while the creature is flat on the ground. In consequence, the strike is made with an initial backward movement of the head, faster than the eye can see, to enable the fangs to move into the striking position, and at the same time the head comes forward in a flash to effect the bite. This forward thrust can be so vigorous that sometimes the snake, and particularly smaller ones, throws its body right off the ground.

The nature of this movement is well-illustrated by a vernacular name of the African Puff Adder, *Bitis arietans*, which refers to the snake 'which has to turn on to its back before it can bite'.

But the best exponent of 'jumping' in Africa is the Night Adder, *Causus rhombeatus*, a fairly slender species which rarely exceeds a length of two feet. I have frequently seen examples of the Night Adder lift themselves off the ground the equivalent of their own length, but by no means all will do this, in fact the majority do not. In order to reinforce the vigour of its strike this species sometimes inflates the anterior third or half of its body, and as it strikes it deflates with such force that the strike becomes a definite 'jump'.

I hope these remarks afford a satisfactory and convincing explanation of a snake's 'jump'.

FLAT 9,
12 CHELSEA EMBANKMENT, C. R. S. PITMAN
LONDON, S.W. 3,
June 16, 1961.

13. UP-STREAM MIGRATION OF ELVERS OF *ANGUILLA NEBULOSA* (=*BENGALENSIS*) OVER FIRST ANICUT OF THE RIVER GODAVARI[1]

(*With one plate*)

During investigations on the freshwater prawn fishery in the river Godavari the author came across the interesting phenomenon of the up-stream run of young elvers of *Anguilla nebulosa* (=*bengalensis*) over the first anicut at Dowleishwaram, situated 80 km. from the sea.

On 26 August 1960, shortly after dusk, small elvers of *A. nebulosa* were noticed negotiating the anicut by slowly moving up-stream along portions of the sloping cement pavement over which the current was sluggish; the movement extended to adjoining areas which were kept moist by spray from the stream. Subsequent regular observation showed that this run of elvers continued throughout the period of overflow of the water over the anicut. It ceased with the stoppage of the overflow towards the end of February 1961. The up-stream migration of the elvers started again in June 1961, when the water once more began to overflow. During the non-flood period, when the shutters of the anicut were raised, the elvers were observed to move vertically up the iron shutters, particularly between two shutters where there was slight leakage.

The anicut at Dowleishwaram covers the entire breadth of the river, 6.4 km., and consists of four sections with islands in between. The shutters, about one metre in height, fall automatically during heavy flood and allow a continuous flow of water, often submerging the entire anicut and maintaining the same water-level on both sides. The run of the elvers was recorded on all edges of the anicut adjoining land.

In all, 452 elvers were collected and measured. The sizes ranged from 48 to 58 mm., the size frequency distribution showing a unimodal curve with a well-defined mode at 53 mm. Nearly 90% of the elvers were between 51 and 55 mm. in length. Microscopic examination of the skin and its scrapings showed no trace of scales on any part of the body.

Rahimullah *et al.* (1944) recorded 152 mm. long elvers of *A. nebulosa* from Nizamsagar Dam, higher up the Godavari River, about 725 km. from the sea. Presuming it to be impossible that

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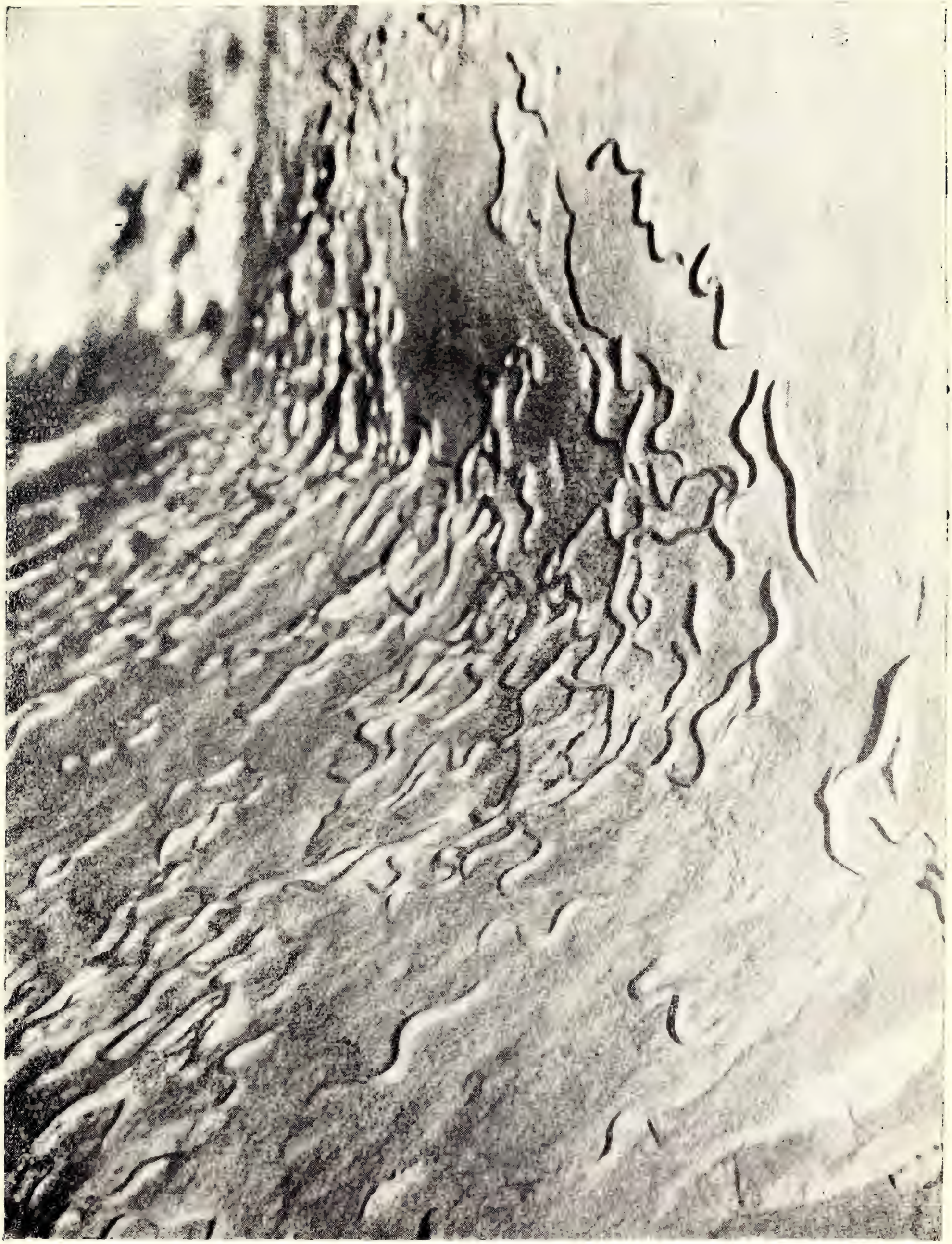
[1] Communicated by the Director, Central Inland Fisheries Research Institute Barrackpore, W. Bengal.



Elvers of *Anguilla nebulosa* (=*bengalensis*) moving up-stream over sloping cement pavement of R. Godavari at Dowleishwaram.

elvers of this size could have overcome the intervening obstacles of two anicuts and some precipitous falls, they opined that *A. nebulosa* probably breeds in fresh water. Pantulu (1956), relying on his study of *A. nebulosa* from Hooghly River, felt that there was not sufficient reason to accept the assumption of Rahimullah *et al.* The present record of successful negotiation of the Dowleishwaram Dam by 49-58 mm. long elvers shows how migration can take place to the upper reaches of the river. Pantulu (1956) recorded a monthly growth rate in *A. nebulosa* from the Hooghly of 9 to 12 mm. for specimens ranging from 47 to 150 mm. Considering the different size groups recorded at Dowleishwaram and at Nizamsagar, we might estimate that the elvers recorded at Dowleishwaram will reach Nizamsagar in about a year.

In the third week of July 1961 in Godavari River elvers were recorded in good number in the fry collection nets operated at Yanam (20 km. from the sea), Kotipally (32 km.), and Kapileshwaram (48 km.). At the first two places 62 elvers were taken in 15 hours of fry collection, and the size frequency showed a well-marked mode at 48 mm. (range of size 45-56 mm., 82% of collection ranging from 47-51 mm.). This along with the facts recorded above is evidence supporting a migration of elvers from the sea to the upper reaches of the river at Nizamsagar.

My conclusions are supported by the observation of Sundara Raj (1916) that every year by about November a number of elvers measuring 2 to 3 in. (50 to 75 mm.) ascend the rivers Cooum and Adyar. I may mention also the observation of Frost (1954) that elvers of *A. nebulosa labiata* ascend Tana River in Kenya, overcoming many waterfalls including a vertical fall of 75 ft. (23 m.).

ACKNOWLEDGEMENT

I am gratefully indebted to Dr. M. P. Motwani for his kind encouragement and critical perusal of the manuscript, and Sri Y. Ramarao of this Institute for supplying me with the elvers collected at Yanam and Kotipally.

CENTRAL INLAND FISHERIES
RESEARCH INSTITUTE,
RAJAHMUNDRY,
October 7, 1961.

K. H. IBRAHIM

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14. THE CALANOID COPEPOD *PSEUDODIAPTOMUS ARDJUNA* BREHM—A NEW DESCRIPTION[1]

(*With one plate*)

Pseudodiaptomus ardjuna was first created by Brehm (1953) for two specimens collected by him from Thana creek, near Bombay, but his description and illustrations are incomplete. Hence, an attempt is made here to illustrate and describe this species in detail from the specimens collected from the plankton samples from Mahim backwater in March 1959.

Pseudodiaptomus ardjuna Brehm

Female. Total length, 1.2 mm. (Plate, fig. 1).

The proportional lengths of the cephalothorax and the abdomen are 63 : 37 = 100.

There are five cephalothoracic segments and the head is fused with the first thoracic segment. Forehead rounded in dorsal view and prominent and arched in side view; posterior thoracic margins produced into small spines directed backwards and outwards; rostral spines small, delicate, and curved downwards and backwards.

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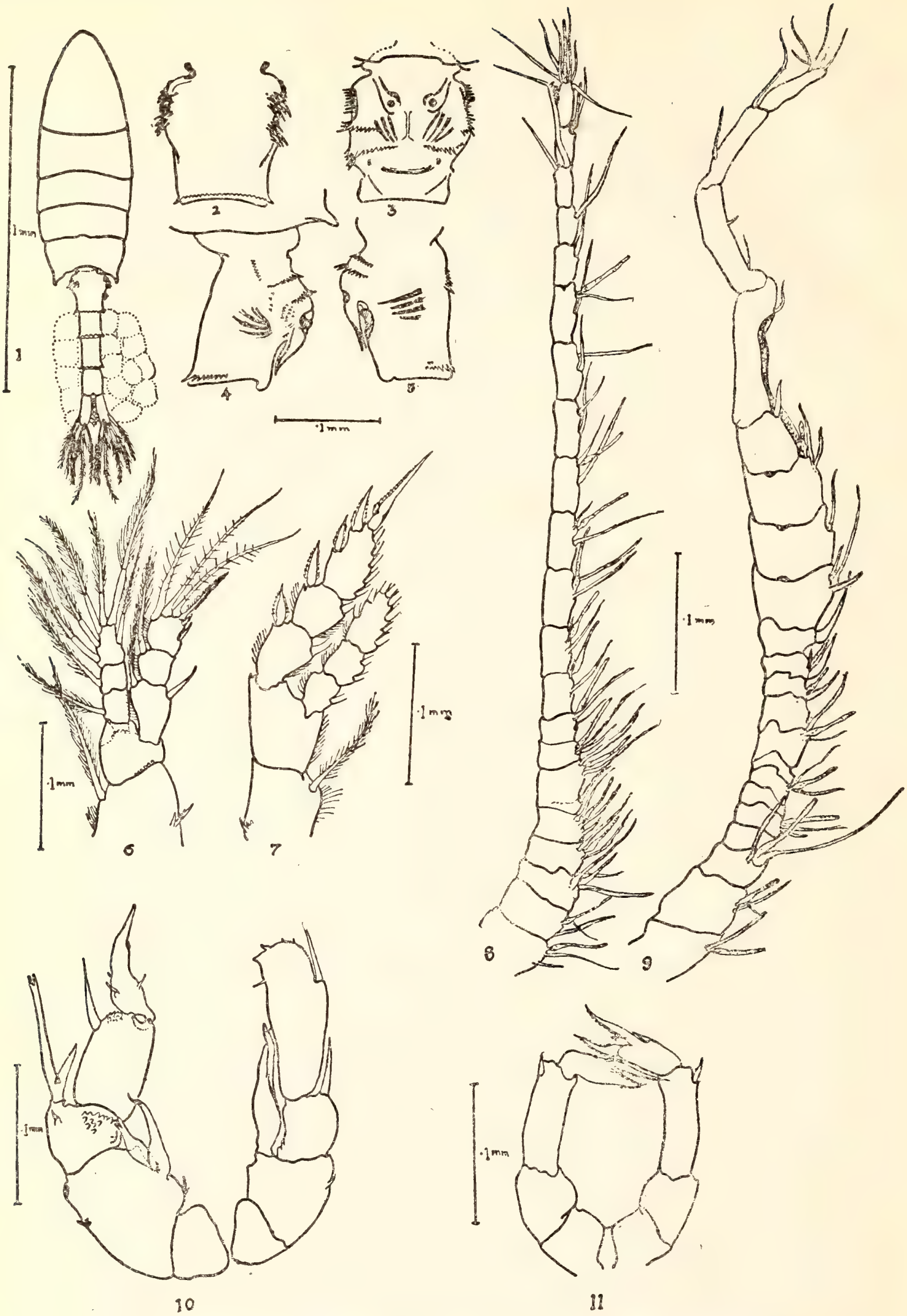
[1] While this paper was still in the proof stages our attention was drawn to a paper entitled ' Studies on Indian Copepods 4. Description of the Female and a Redescription of the Male of *Pseudodiaptomus ardjuna* Brehm (Copepoda, Calanoida) with Notes on the Distribution and Affinities of the Species', by A. N. P. Ummerkutty [*J. Mar. biol. Ass. India*, December 1960 (published on 11-11-1961) **2** (2) : 179-185] in which specimens obtained in the Gulf of Mannar and the Palk Bay are described. We have, therefore, in consultation with the authors deleted the descriptions of the swimming legs, and are retaining the rest as there appear to be some differences in the two accounts.—Eds.


1 mm
1
2
3
4
5
·1 mm
6
·1 mm
7
·1 mm
·1 mm
8
9
·1 mm
10
·1 mm
11

The Calanoid Copepod *Pseudodiaptomus ardjuna* Brehm

1. ♀ entire, dorsal; 2. ♀ genital segment, dorsal; 3. ♀ genital segment ventral; 4. ♀ genital segment, right side; 5. ♀ genital segment, left side; 6. ♀ 1st swimming leg; 7. ♀ 2nd swimming leg; 8. ♀ 1st antenna; 9. ♂ 1st right antenna; 10. ♂ 5th pair of legs. 11. ♀ 5th pair of legs.

The abdomen consists of four segments, the proportional lengths of which are as follows:

Abdominal segments				Furca	
1	2	3	4		
26	19.5	21	14	19.5	= 100

The genital segment is asymmetrical in shape and is the largest of the abdominal segments. Its surface is ornamented with an elaborate system of spinules distributed in different groups (Figs. 2, 3, 4, 5). On the ventral side the genital orifice is guarded by two backwardly projecting spines. Posterior margins of the abdominal segments 1, 2, and 3 are fringed with triangular teeth along their dorsal aspect only. They gradually decrease in size towards the lateral sides. Furcal rami are thrice as long as broad and are lined with coarse hair along their inner margins. There are six furcal setae; the second is the smallest and is situated somewhat dorsally.

Ovigerous female has a single ovisac with about 22 to 25 eggs.

First antenna (Fig. 8) reaches back to about the posterior margin of the genital segment and consists of 21 segments, the proportional lengths of which are as follows:

Segments:	1	2	3	4-5	6-7	8-9	10	11	12	13	14
	48	40	28	36	36	24	32	32	48	56	60
	15	16	17	18	19	20	21	22	23	24-25	
	64	68	68	64	60	40	44	48	48	56=1000	

Segment 19 has a modified strong seta with margin serrated along its inner side.

The remaining mouth parts are similar to those of the other members of the genus like *P. serricaudatus* and *P. hickmani*.

Male. Total length, 1 mm.

Proportional lengths of cephalothorax and abdomen are 68 : 32 = 100.

There are five abdominal segments, the proportional lengths of which are:

Segments						
1	2	3	4	5	Furca	
9·5	23	22	9	11.5	15	= 100

Posterior margins of the segments 2, 3, and 4 are fringed with teeth as in the female.

1st right antenna (Fig. 9) is modified to form a grasping organ. It has 21 segments and it resembles the grasping antenna of *P. hickmani*.

Fifth pair of legs (Fig. 10):

The structure of the fifth pair of legs is the main distinguishing character of this species. It resembles to some extent the structure of the same appendage of *P. hickmani* (Sydney variety) as figured by Dakin & Colefax (1940). The 2nd basal of the right side has double spinous processes (endopod), one with a small hairy projection on the tip and the other with a bifid tip. The latter is missing in the figure given by Dr. Brehm. It is observed that this structure is usually lost in handling of specimens. Exopodite is three-jointed. First segment has a Y-shaped spinous process with the inner short and the outer long arm with the bifid tip. There is a small spine at its base. Along its inner anterior face there are 15 to 18 strong blunt teeth arranged in U-shape. Second segment has a spine distally on outer margin and a few teeth in front of its base. Third segment is sickle-shaped. On the left side, the endopodite is sickle-shaped but it has a bifid tip. Exopodite is two-jointed. First segment has a spine distally on its outer margin. Second segment is a plate-like structure, twice as long as broad, with a spine on its outer margin distally. Its distal margin is serrated and produced into a beak-like structure on its inner extremity.

Discussion

Apparently the sketches given by Dakin & Colefax (1940) for *P. hickmani* resemble our specimens in many respects, but *P. ardjuna* can be easily distinguished from the former by the structure of the 5th pair of legs in the male.

The Thana creek from which Dr. Brehm collected his specimens, as well as the Mahim backwater from which the present specimens were collected were formerly confluent water masses. The reclamation programme of the Bombay Municipal Corporation has separated these two bodies of water in recent years. No specimen of this species was, however collected from the offshore waters of Bombay, tending to show that it prefers low salinity.

We take this opportunity to thank Dr. S. Krishnaswamy, Reader in Zoology, Zoological Research Laboratory, University of Madras, Madras, for his valuable suggestions, and Mr. M. C. Joshi for supplying the material.

INSTITUTE OF SCIENCE,
BOMBAY,
July 10, 1961

H. V. DESAI
D. V. BAL,
Ph.D.

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15. MIGRATION OF BUTTERFLIES

This report is sent to place on record a migratory flight of butterflies witnessed by me on 4 August 1961. I first noticed it at about 9 a.m. at Sathuperi, about 7 miles south-west of Vellore, three Common Indian Crows (*Euploea core* Cramer) and one Blue Tiger (*Danaus limniace* Cramer) floating slowly in a NE. to SW. direction. At the time I was on my way to Kammavanpeth, 15 miles south of Vellore. All the way the flight continued, butterflies crossing the road singly or in twos or threes, flying from a few inches to a few feet above the ground except when clearing obstacles, all flying in the same direction NE. to SW. At Kammavanpeth the migration was still in progress but rather thin. As a rough test I counted the number of butterflies passing between two trees about 60 feet apart. The figures were:

1st 5 minutes: 4 *D. limniace*
2nd 5 minutes: 3 *D. limniace* and 1 *E. core*
3rd 5 minutes: 1 *D. limniace*
4th 5 minutes: nil

The migration was still in progress along the whole distance of 15 miles when I drove back to Vellore at 11 a.m. At places it appeared to be denser than at Kammavanpeth, but it was difficult to estimate with certainty when driving a car. Except at Kammavanpeth, the number of *E. core* exceeded that of *D. limniace*.

A few butterflies were seen in Vellore town, one crossing the main street.

VIRUS RESEARCH UNIT,
C.M.C. HOSPITAL, R. REUBEN
VELLORE,
September 13, 1961.

16. OCCURRENCE OF THE BLUE MORMON (*PAPILIO POLYMNESTOR* CRAMER) IN BOMBAY

In my Miscellaneous Note dated 13 April 1960 [*J. Bombay nat. Hist. Soc.* **57** (1) : 231-3], I reported the occurrence of the Blue Mormon butterfly (*Papilio polymnestor* Cramer) on Pali Hill in Bandra and, having special regard to the uniformity of the direction of flight observed by Mr. Basil W. Wirth at Colaba, I suggested that this might be a case of local migration. Further observation on Pali Hill shows that *P. polymnestor* occurs in several months of the year, and that it does not fly in any one direction. My observations, made in the compound of No. 49 Pali Hill and its immediate neighbourhood, are as follows:

Month	1960	1961	Remarks
	No. of days on which seen / No. of times seen	No. of days on which seen / No. of times seen	
January	nil	1/1	
February	1/1	1/1	
March	1/1	7/10	
April	nil	5/7	
May	nil	No observations	
June	nil	nil	
July	5/7	nil	
August	nil		No observations after July 1961
September	6/6		
October	7/12		Seen 4 times on one day. Flitted about in the garden on two days.
November	11/20		Seen flitting about in the garden on three separate occasions.
December	3/3		

On every occasion only one butterfly was to be seen. The impression created was of one butterfly moving about in a restricted area and being seen from time to time. For some days the butterfly had a portion of a wing damaged and so it was possible to identify it in several successive appearances.

In view of the facts noted it does not appear likely that Pali Hill is merely a point on a route of local migration. It is possible that there is a seasonal appearance of the butterfly on Pali Hill, a possibility that can only be tested by observations over an extended period.

49 Pali Hill,
Bandra,
Bombay 50,
November 3, 1961.

D. E. REUBEN

17. MASS OCCURRENCE OF THE PREDATORY STINK BUG, *CANTHECONIDIA* (*CANTHECONA*) *FURCELLATA* (WOLFF.) ON *AMSACTA ALBISTRIGA* WALK. IN SOUTH INDIA[1]

The red hairy caterpillar, *Amsacta albistriga* Walk. (Arctiidae, Lepidoptera), is a very serious pest of the dry crops, especially groundnut, in most of the rain-fed tracts of Madras State. Apart from the record of the parasite *Apanteles creatonoti* Vier. (Ramakrishna Ayyar & Margabandu, 1934) in Mysore, there seems to be no record of any natural enemies on the pest under field conditions in India. Under laboratory conditions the eggs were found to be parasitised by *Trichogramma* sp. in Mysore (Kunhi Kannan, 1931), and the larvae attacked by the pentatomid bug *Cantheconidia furcellata* (Wolff.) in Coimbatore (Cherian & Brahmachari, 1941). Recently, however, during a study tour to the southern districts, the bug *C. furcellata* (Wolff.) was observed in the field to account for considerable mortality of the caterpillars of *Amsacta albistriga* Walk. in Alagarkoil area (Valayapatti village) of Melur taluk in Madurai district. Since this is the first time that it has been found to exercise some natural check on the pest in the field, a short account of the insect is given here.

While studying the recent outbreak of the hairy caterpillar pest on groundnut crop in Alagarkoil area it was observed that many dead caterpillars were hanging, head downwards, from the under surface of the leaves of the redgram (*Cajanus cajan* Mill.) plants on which they were found resting after devastating the whole groundnut crop. On examination it was found that the mortality of the caterpillars was due to the attack of the bug *C. furcellata* (Wolff.). A very large number of the bugs were present on the redgram plants, and the last instar nymphs and the adults of the bug were attacking the caterpillars of advanced stage, i.e. from the third instar onwards. The mode of attack was to approach the caterpillar from behind, place the rostrum in between the two anal prolegs, and thrust the stylets into the posterior part of the larva. Most probably the young bugs breed on the redgram plants or weeds in the locality. This is in conformity with the observation of Cherian & Brahmachari (1941) that the bugs feed at first on the plant sap and only later turn their attention to the insect-food.

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[1] Communicated by the Dean, Agricultural College & Research Institute, Coimbatore.

Cantheconidia furcellata (Wolff.) has a wide distribution. It occurs in Formosa, Malaya, Borneo, Philippines, India, Ceylon, Burma, Java, etc. and is well known as a predator of lepidopterous larvae. In India so far it has been noted from Bihar, Bengal, Calcutta, Ranchi, Bombay, Madras, Coimbatore, Saidapet, Musiri, and Aduthurai. Previous records in India show that it has been noted as predaceous on larvae of *Laphygma exigua* Hb. (Vassiliev, 1914), *Prodenia litura* Fb., *Athalia proxima* Kl. (Ballard, 1922), *Thosea cervina* Moore (Ananda Rau, 1936), *Utetheisa pulchella* Linn. in Central Provinces (Fletcher, 1917), *Hybloea puera* Cram., Tusser silkworms *Antherea* sp. (Distant, 1902), *Semiothisa pervolgata* Wlk., *Terias hecabe* Linn., *Catopsilia pyranthe* Linn. (Cherian & Brahmachari, 1941). Under laboratory conditions (*loc. cit.*) the bug was noted attacking the caterpillars of *Tarache nitidula* Fb., *Earias fabia* Stoll., *Orthaga* sp., *Spodoptera mauritia* Boisd., *Cirphis unipuncta* Haw., *Psalis securis* Hubn., *Euproctis fraterna* Moore, *Argina cribraria* Clerck., *Hypsa sericae* Moore, *Utetheisa pulchella* Linn., *Amsacta albistriga* Walk., *Eupterote mollifera* Wlk., *Stomopteryx nerteria* Meyr., *Sylepta derogata* Fabr., *Schoenobius incertellus* Wlk., *Scirpophaga* sp., *Papilio demoleus* Linn., *P. aristolochiae* Fab., *Acherontia styx* Westw., *Melanitis ismene* Cram., and *Parnara mathias* Fabr. Fletcher (1914) has reported an instance wherein the bug was bred in large numbers and released in cotton and gram fields to check caterpillar attacks on these crops. In the Insect Collections at the Agricultural College & Research Institute, Coimbatore, a few bugs have been collected as predaceous on the larvae of *Athalia proxima* Kl. (Coll: T. V. R. Ayyar, 1912), *Chloridea* sp. on cotton (Coll: M. S. Kylasam, 1929), and *Thiacidas postica* Walk. on *Zizyphus* (Coll: T. V. Subramanian, (1936).

Recent researches have indicated that the pest *A. albistriga* Walk. can be controlled by dusting BHC. 10% at its most vulnerable stage, i.e. when the caterpillars are a week old. Spraying 0.05% Parathion to control grown-up caterpillars is practicable only in places where there are water facilities available. Inasmuch as the bug has been previously utilised by breeding and liberating in cotton and gram fields for controlling caterpillar pests of the crops, it may possibly be used in the biological control of the red hairy caterpillar *A. albistriga* Walk.

POST-GRADUATE TRAINING
CENTRE,
COIMBATORE,
October 28, 1960.

B. VASANTHARAJ DAVID
M. BASHEER

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18. STRANGE BEHAVIOUR OF SOME DRAGONFLIES

Chandola is a large irrigation lake three miles south of Ahmedabad situated on the Ahmedabad-Bombay National Highway. Since I started taking an interest in nature study more than thirty years ago, Chandola Lake has been my field observatory for the study and collection of butterflies, dragonflies, and other insects, fishes, birds, and lately spiders. When full of weeds, it is populated by a large number of dragonflies.

I have noticed that, whenever I move on the bank of the Lake on my bicycle, a number of dragonflies fly parallel with my back wheel, about 8″-12″ off and keep company. A sudden burst of speed or slowing down does not inconvenience them, and they immediately accelerate or decrease their speed. If I brake and stop, they also stop without moving even a foot further and then disperse, some resting on ground, some on grass stems, and some flying away. The moment I start my bicycle again, several dragonflies collect from somewhere (I am not sure if they are the same insects) and fly parallel to the back wheel. They follow me for a distance of 50 to 100 yards according to where I stop. This is not an isolated experience. It has occurred time and again, more or less regularly, for a number of years in seasons when dragonflies were plentiful. Their number varies from 10 to 50. I have been too lazy to collect specimens and hence am unable to name the species, but they invariably belonged to that drab or dull (yellowish brown) coloured, short and thick-bodied kind of insects grouped under the sub-order Anisoptera of the order Odonata. None of the brilliantly coloured slender-bodied Zygroptera was ever found to indulge in this pastime.

What is the explanation of this peculiar behaviour on the part of the dragonflies? Apparently, they seem to be attracted by the spinning back wheel (why not the front wheel?) or is the whirring sound of the fast moving wheel the cause of this strange behaviour? That excellent book DRAGONFLIES by Corbet, Longfield, and Moore (New Naturalist, Collins, 1960) does not refer to any such habit.

In this connection, there is one side of the dragonfly character which should not be lost sight of. They are by nature fun-loving insects. They continuously chase each other without any apparent reason, and also fight with each other if they are near water. Perhaps this habit of continuous movement may be responsible for the peculiar behaviour referred to above, being attracted by the moving wheel. A dragonfly sitting or resting on a weed or branch of some bush will immediately leave its perch if another dragonfly flies over it and will fly after the other.

Or is the action similar to that of flies (?) collecting round or over the head of a human being in the form of a cloud, a thing we often see?

GUJARAT NATURAL HISTORY SOCIETY,
AHMEDABAD, HARINARAYAN G. ACHARYA
November 15, 1961.

19. ASYMMETRICAL POSITION OF PALE ANTENNAL SEGMENTS OF *PARALABIS DOHRNI* (KIRBY) (LABIDURIDAE, DERMAPTERA)

(*With one text-figure*)

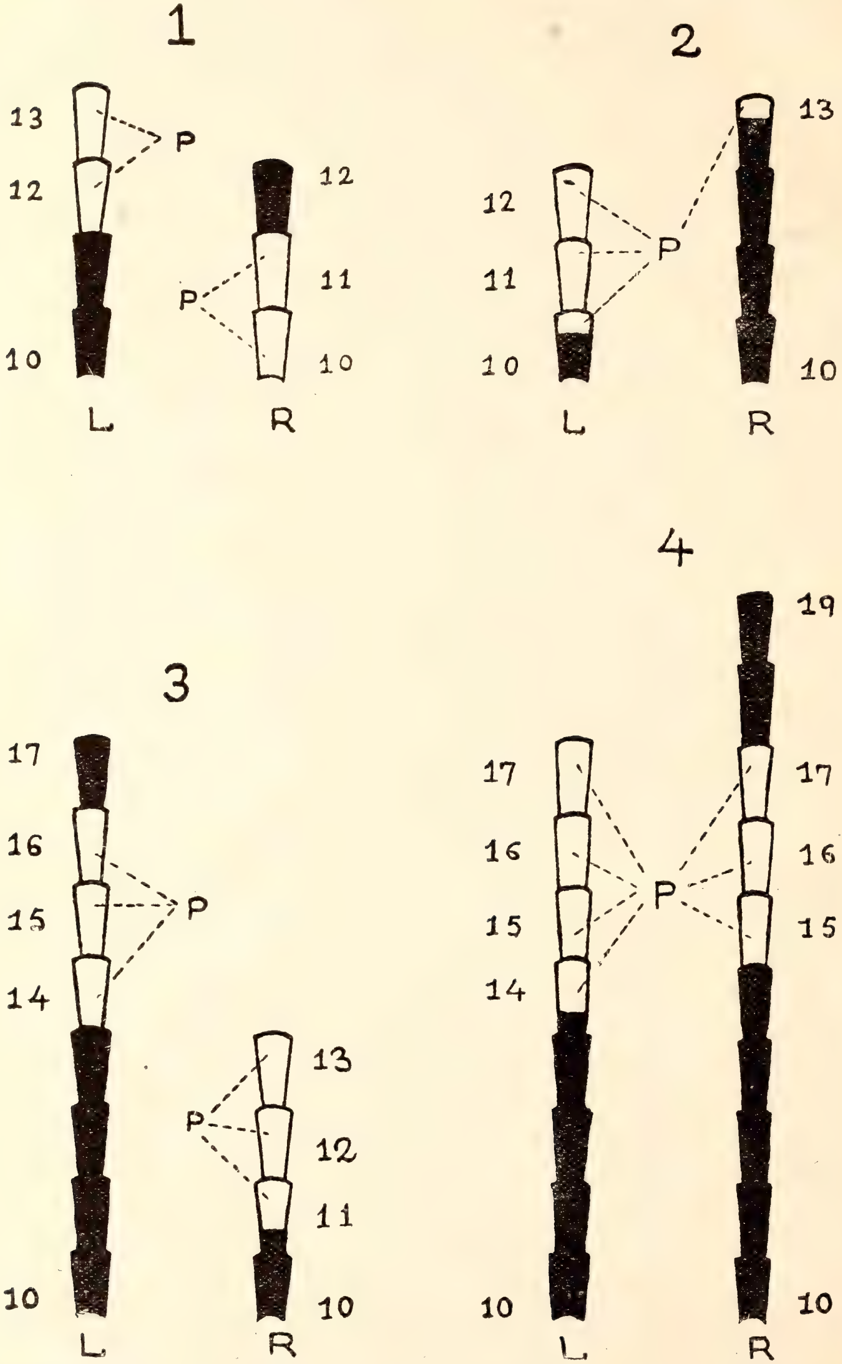
In an attempt to identify the earwig *Paralabis* (*Psalis*) *dohrni* (Kirby), I was struck by the fact that the position of the pale antennal segments varies not only between different specimens of the species but also between the left and the right antennae of the same specimen (see text-figure). This was confirmed by the examination of more than fifty specimens, handpicked from gardens in Poona and found generally under earthen flower pots (*kundis*). Out of the total number examined two specimens had no pale segment and in four there was symmetry between the antennae. In the table below I give details of 11 of the specimens examined by me.

TABLE

Some asymmetrical positions of the pale antennal segments of *Paralabis dohrni* (Kirby)

Sp. No.	Left Antenna		Right Antenna	
	Total No. of segments	Serial Nos. of pale segments	Total No. of segments	Serial Nos. of pale segments
1	13	12, 13	12	10, 11
2	17	14, 15, 16	13	11 (3/4), 12, 13
3	17	14 (3/4), 15, 16, 17	19	15, 16, 17
4	14	12, 13	12	12
5	18	14 (3/4), 15, 16, 17 (3/4)	17	15, 16, 17
6	15	13, 14, 15	17	13, 14, 15
7	14	14 (1/4)	14	12 (1/4), 13 (1/4), 14
8	18	14, 15, 16	12	10 (1/4), 11, 12
9	12	10 (1/4), 11, 12	13	13 (1/4)
10	16	13 (1/4), 14, 15	17	13 (1/4), 14, 15
11	17	nil	11	nil

The late Dr. W. D. Hincks (1960, personal communication), of the Manchester Museum, to whom I am grateful for confirming


1
13
12
P
12
11
P
10
10
L
R
2
13
12
P
11
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10
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3
17
16
15
P
14
13
P
12
11
10
10
L
R
4
19
17
17
16
16
15
P
15
14
10
10
L
R

FIG. 1: Some of the asymmetrical positions of the pale antennal segments of *Paralabis dohrni* (Kirby). L: Left antenna. R: Right antenna. P: Pale segments. Nos. 10, 11, 12, etc.: Number of antennal segments.

my identification observed: 'It should be remembered that the significant segment in the development of the antennae is segment 3, which divides from instar to instar producing an increasing number of segments per instar. The increase exhibits a different pattern in different species but within a species the pattern is surprisingly constant. Occasionally something goes wrong with this process producing a slightly different pattern in a particular individual, which may thus be asymmetrical if only one side is affected or symmetrical if both sides are equally influenced.' If Dr. Hincks's suggestion is correct and the asymmetry is attributable to an accidental cause, it is remarkable that it should be found in such a large proportion of the cases examined.

Similar asymmetry in the distribution of the pale antennal segments was observed in *Euborellia annulipes* (Lucas), but I have not kept a detailed record of my observations.

RESEARCH LABORATORY,
ZOOLOGY DEPARTMENT,
N. WADIA COLLEGE,
POONA 1,
July 20, 1961.

P. V. JOSHI

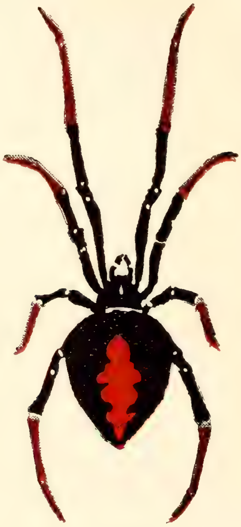
20. OBSERVATIONS ON THE SPIDER *LATRODECTUS HASSELTII INDICUS* SIMON WITH A NOTE ON ARACHNIDISM

(*With a text-figure*)

On 17 June 1961 a female spider *Latrodectus hasseltii indicus* Simon, carrying a cocoon was collected by the junior author (PWS) under a stone in open scrub country on the tableland 2000 ft. at Suriamal in north Thana, Bombay. The spider was kept alive for observation some time. To the account in Pocock's FAUNA volume on Arachnida which is restricted to the size and colour of the female (?) it may be added from observation of this specimen that the two terminal segments of all the legs of the adult female are reddish brown in colour. The following further notes may be of interest.

On the 18th, in transport and transfer to its new home in a rectangular glass jar (20.5 × 10 × 24 cm.) the spider and the cocoon were separated, the latter lying on the bottom. However, during the night the spider spun a few strands in a corner of the jar *c.* 10 cm. off the bottom, recovered the cocoon, and attached it to the web. She showed no further interest in it though she usually spent the day on the web quite close to the cocoon. On 22 June a second cocoon, similar in dimensions to the first, was spun quite close to the first on the same web. The cocoons were white in colour, coarse-textured, spherical in shape, with a diameter of 10 mm.

On 9 July, 23 days after collection, young emerged from the first cocoon, and on 13 July from the 2nd cocoon, 22 days after it was spun. The spiderlings emerged through a small circular hole on the cocoon. There are instances of the mother spider of other species aiding the young by perforating the cocoon; in the present case the young emerged at night and we were unable to make any observations. The young spiders remained mainly on the web strands and on the muslin cover of the jar. The spiderlings from the two cocoons totalled 304, but it was not possible to keep separate counts.



×2

The spiderlings differ markedly from the adult in colour and body pattern. Unlike the jet black of the adult with the patches of scarlet on the upper side of the abdomen and at the tip of the lower side of the abdomen, the young are mainly white and brown. The thorax is pale brown above and below, with a black border to the edge of the sternum; abdomen white above with four black spots arranged distally in pairs and a large pale brown proximal spot, a middle brown patch, and a distal smaller brown spot, all situated along the mid abdomen; ventrally white, with a black line along the sides, which end above the spinneret; fangs black; legs translucent brown. Size less than 1 mm. in length.

The cocoon and the colour of the young are in many respects similar to those of the American species *Latrodectus mactans*.

The adult was fed on flies and black ants (*Crematogaster* sp.), but there are records of the species feeding on much larger insects. The young were to a certain extent cannibalistic. None survived.

The genus *Latrodectus* is widely distributed, and is regarded as particularly dangerous in widely separated parts of the world: *L. menavodi* in Madagascar, *L. katepo* in New Zealand, *L. geometricus* and *L. indistinctus* in Africa, the Black Widow (*L. mactans*) in West Indies and North America, and the Karakurt or Black Wolf (*L. tredecimguttatus*) in Southern Europe.

A comprehensive article on arachnidism entitled 'The health problem of Arachnidism' by Z. Marectic and M. Stanic, based on their observation and work, clinical and otherwise, in combating an outbreak of Arachnidism in the Istrian region of Yugoslavia in the late forties and early fifties, was published in the *World Health Organization Bulletin*, 1954, **11** : 1007-1022. The notes below are compiled from that article as very little information is available on the subject in India, where only one little-known species occurs.

In south Europe, where *L. tredecimguttatus* the type species of the genus is common, there appear to be periodic fluctuations in the number of specimens seen. In some years the spiders are found in enormous numbers and then disappear for years, even decades. In Austria and Yugoslavia, it is said to be extremely common and to be collected from almost every square yard. The spider is not aggressive, biting only in self-defence. During the period 1948-53 over 180 cases, mostly among agriculturists, were treated.

The effect though serious is not usually dangerous to life. The reactions follow a set pattern. The first symptom, which appears in 10 to 20 minutes or in some cases even an hour or more later, is a burning sensation at the site of the bite followed by pain in the lymphatic nodes (axillary or inguinal). This is followed by a feeling of pressure in the chest and pain in the belly, back, and extremities, particularly the legs. Intense agonising pain is in fact the main symptom. In serious cases the patient is unable to stand erect and becomes stiff. There is increased tendon reflex, profuse sweating, sometimes shedding of tears, excessive salivation or a dry mouth, convulsion, and in some cases tetanic spasms of the jaw muscles. There is also considerable restlessness, the patient having an urge to move and walk, is convulsed and writhes. These movements, also noticed in experimental animals, give a certain amount of relief from pain, and are believed to be the origin of hysterical taranterism, from which originated the name of the Tarantella dance.

The symptoms in untreated persons last for a week and convalesence takes a month or more. There is considerable loss of weight, one patient having lost 5 kg. in 3 days. In experimental animals there is an instance of a rat having lost 20% of its weight in 24 hours.

Curiously enough the effect of the venom on different animals varies and the relative size of the animal appears to be of no importance. The poison is deadly to camels and horses (a horse injected with the macerate of a single spider died within 24 hours) but has no effect on goats! Among the smaller animals mice are highly sensitive, death following a bite in 10 to 20 minutes. Rabbits and dogs are resistant. The venom has no effect on reptiles. It is especially effective on nerve cells, and is believed to have a toxic effect 15 times greater than that of the rattlesnake. The venom is of a clear lemon-yellow colour. The Ph changes with temperature, becoming alkaline above 25° C. and consequently more toxic. It is also established that the venom of different species is practically identical and anti-venom against the bite of one species gives equal protection against allied species. The method of treatment which gave the best results was simultaneous application of anti-venom and calcium; however, injection of calcium salts alone in the absence of anti-venom would be sufficient to give relief. An intravenous injection of calcium gluconate, chlorate, or bromate gives immediate and great relief from pain. The pain may recur but these relapses run a milder course. Several injections of calcium are recommended to complete the treatment.

The bite of most species of spiders causes no more harm than momentary discomfort.

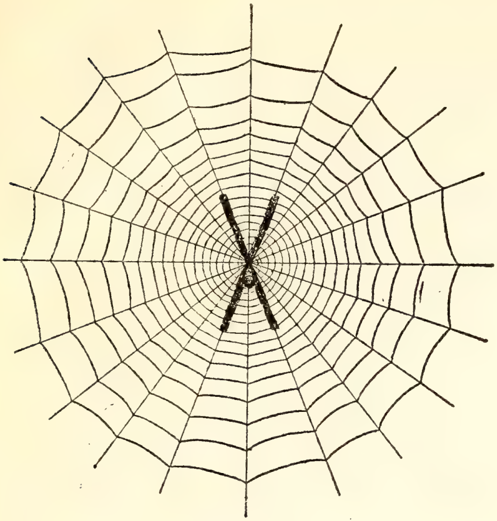
BOMBAY NATURAL HISTORY SOCIETY,
91, WALKESHWAR ROAD,
BOMBAY 6,
November 22, 1961.

J. C. DANIEL
P. W. SOMAN

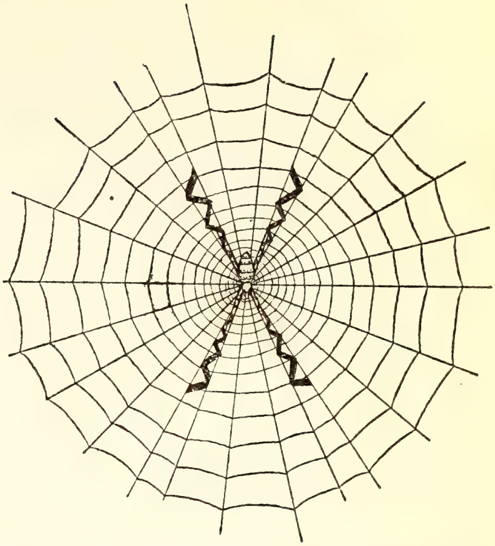
21. PROTECTIVE DEVICES OF SOME ORB-WEAVING SPIDERS FROM INDIA

(*With nine text-figures*)

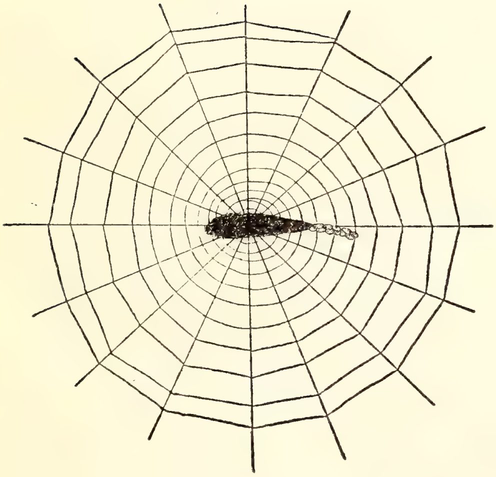
In the course of my field collections of spiders in India I have come across interesting examples of protective devices, mainly among the orb-weaving spiders. In this note I summarise some of my observations.



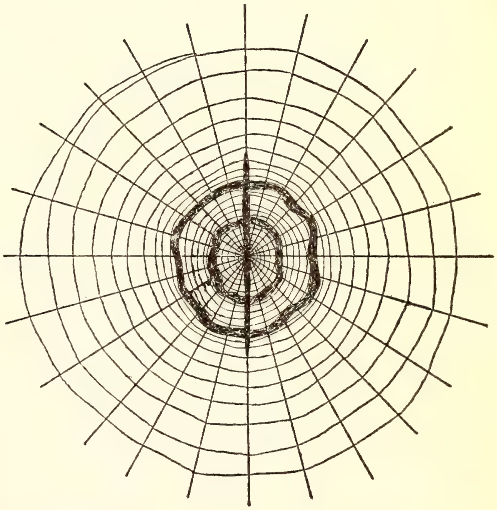
Text-fig. 1. Web of *Argiope arcuata*, with X-shaped protective band



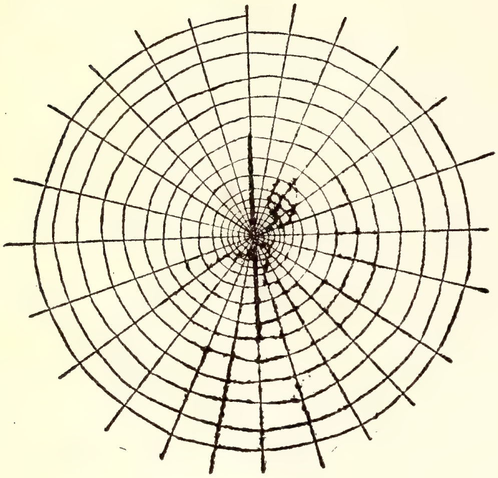
Text-fig. 2. Web of *Argiope pulchella*, with zigzag protective band



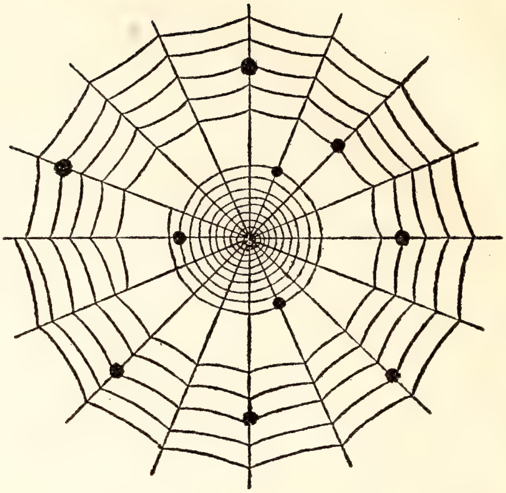
Text-fig. 3. Web of *Uloborus* sp. with broad protective band



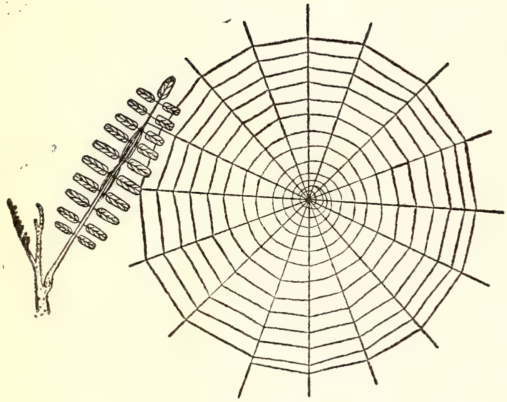
Text-fig. 4. Web of *Cyclosa* sp. with circular protective bands



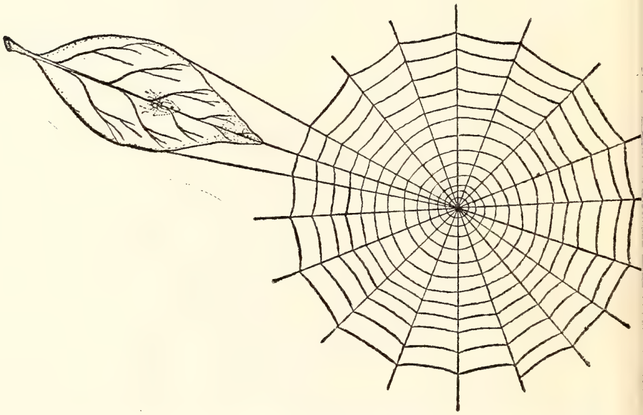
Text-fig. 5. Web of *Cyclosa* sp. with rod-like protective band



Text-fig. 6. Web of *Gasteracantha arcuata*, with protective masses of waste products



Text-fig. 7. Web of *Tetragnatha mandibulata*, with the spider sheltering in the leaf of a leguminous plant



Text-fig. 8. Web of *Araneus dehaanii*, with a leaf attached

At first sight it must seem rather strange that the customary position of a spider, in the middle of its web, is the one in which the creature is conspicuously exposed to every prey and enemy.

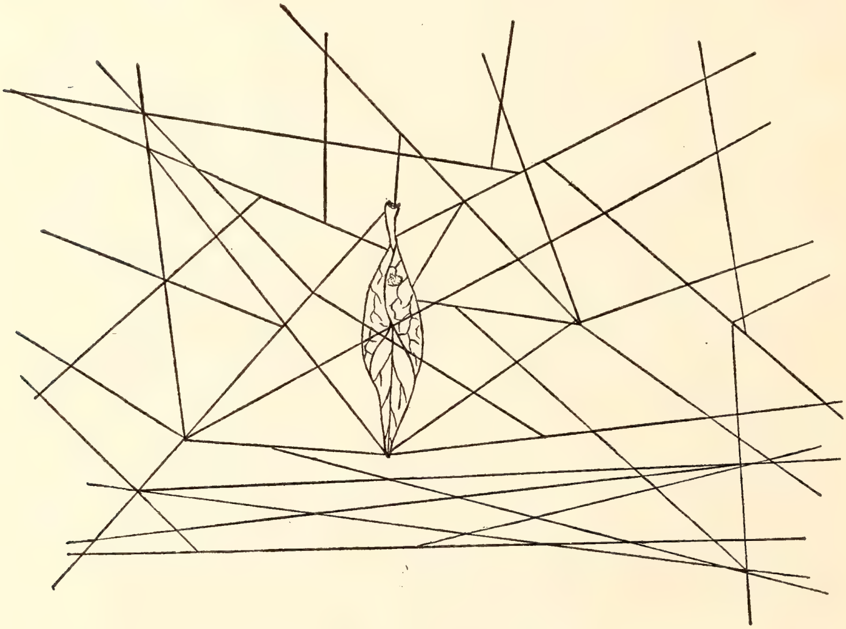
The spiders of the genus *Argiope* are true orb-weaving spiders and are very common all over India. All the known species are beautifully coloured on their abdomen. They construct a net web, often suspended between two adjoining branches of low-growing plants. It is a large orb-shaped construction with four characteristic white silken lines, making an 'X' in the centre. On these four white lines the spider places its four pairs of legs in such a manner that one is not able to see the spider from the other side. The spider hangs vertically, head downward. If anybody approaches the web from the front, the spider immediately goes to the other side and at the same time vibrates the entire web in such a way that one cannot see the spider. *Argiope arcuata* Simon makes the 'X' with wide ribbon-like bands (Text-fig. 1). *Argiope pulchella* Thorell does so with zigzag lines (Text-fig. 2).

Some species of *Uloborus* from western Sikkim occur on rock. It is very difficult to spot these spiders on their webs. They prepare their webs a few centimetres from the rock and at the centre of the web is a spreading band. The spider and the band are of the same colour. The spider hangs downward just behind the central band, and sometimes the egg mass also hangs along the band (Text-fig. 3). A *Cyclosa* sp. from Shillong illustrates an extension of this mode of concealment. It spins the central shield and round it adds rough irregular circles of silk ribbon. These circular ribbons have a protective value and the spider sits just behind the central ribbon (Text-fig. 4).

I have collected other species of *Cyclosa* from Sikkim. They prepare their web in the normal way but in the centre of the web they place vertically a rod-like band, in the middle of which there is a small gap of dimensions depending on the size of the spider (Text-fig. 5). When the spider rests in the gap, the band seems like a continuous straight line. Different species of *Cyclosa* may be of different colours, e.g. one is silvery white and another ash-coloured. The colour of the protective band corresponds to the body colour.

The spiders of the genus *Gasteracantha* have large abdomens and are beautifully coloured, and move very slowly. I have collected some specimens of *G. arcuata* Fabr. from Kalimpong, West Bengal. At first I was unable to discover the spider in the web but on careful observation I detected it at the centre of the web, among many rounded masses of waste products, woven by the spider itself and almost similar in colour and size to the spider, scattered about on the web (Text-fig. 6). I have collected *Tetragnatha mandibulata* Walcknear from the twigs of a leguminous plant overhanging a tank near Jodhpur, Rajasthan. The spider prepares its web so that some of the twigs or leaves are in the web, and during the day rests among them with its legs stretched out before and behind in line with its body (Text-fig. 7).

Araneus dehaanii Dol. is a large spider but in the day-time it is difficult to find it in the web. I saw many new webs, here and there, on the bank of Tista River near Nayabazar but not a single spider. After careful observation I saw at least one big leaf of an adjacent plant attached to each web and the spider resting during the day-time just below the mid-rib of the leaf (Text-fig. 8).



Text-fig. 9. Web of *Theridion* sp. enclosing dry leaf

Some species of *Theridion,* from Maharashtra and Mysore, prepare their web in a very irregular manner in the bushes. The spider places at least one dry leaf in the middle of the web in such a manner that the leaf is attached to the web. The spider rests inside the cavity of the twisted dry leaf, and comes out only at the time of catching its prey (Text-fig. 9).

WESTERN REGIONAL STATION,
ZOOLOGICAL SURVEY OF INDIA,
POONA,
September 6, 1961.

B. K. TIKADER

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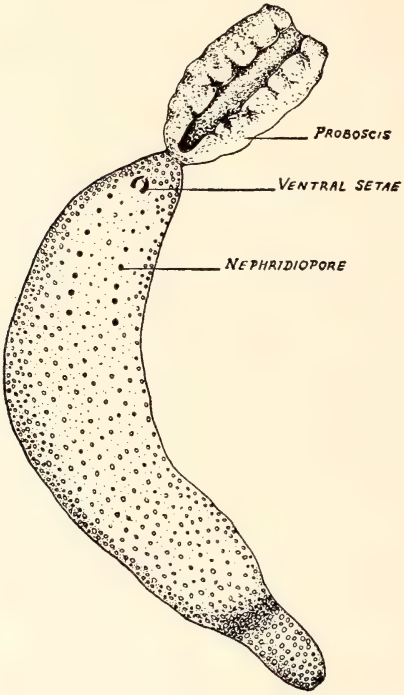
22. OCCURRENCE OF THE ECHIUROID *OCHETOSTOMA ZANZIBARENSE* STEPHEN IN THE GULF OF KUTCH

(*With a text-figure*)

We found the interesting Echiuroid *Ochetostoma zanzibarense* Stephen in the low tide belt of Pirotan Island in the Gulf of Kutch, 10 miles off Jamnagar, on 22 September 1960. The specimen was lying about 1 foot deep in the water on the coral reef in the beacon area south-west of the island. On lifting the specimen from the water we noticed the peristaltic movement of the animal, the waves of contraction passing from the anterior to the posterior end.

The live animal was a little over 7 inches in length including the proboscis and was greenish red in colour. The proboscis is a solid structure, about an inch in length and pale yellow in colour. The lateral margin of the proboscis is inflected. The region of attachment of the proboscis and the body is very delicate. The body is covered over by green papillae. There is a pair of ventral setae. The longitudinal muscles are divided into 12 bands. The nephridia are of characteristic shape with spirally coiled filaments. The anal vesicles are sac-like.

Dr. A. C. Stephen of the Royal Scottish Museum, whom we consulted about its identity, very kindly sent us all the available literature on Echiuroids. On comparing our observation with Stephen's description (1952) we identify this specimen as *Ochetostoma zanzibarense* Stephen. Since its discovery from Zanzibar in 1952 nobody reported the animal. This is the second report on the occurrence of echiuroids from the Gulf of Kutch, the first being that of Gideon *et al.* (1956).



Ochetostoma zanzibarense Stephen

We are grateful to Principal S. M. Mitra, D.SC., for his interest and encouragement throughout the work.

DEPARTMENT OF ZOOLOGY,
BIRLA COLLEGE,
PILANI, RAJASTHAN,
August 21, 1961.

A. K. DATTA GUPTA
P. K. B. MENON

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23. A NOTE ON THE FLOWER COLOUR OF *POLYGALA ERIOPTERA* DC.[1]

Polygala erioptera DC. is an annual herb, generally flowering and fruiting in August-October, sometimes up to March. The colour of the flowers has been variously described by several authors.

According to Dalzell & Gibson (*Bom. Fl.* 13, 1861 under *P. vahliana* DC.), Cooke (*Fl. Pres. Bom.* 60, 1901), Duthie (*Bot. Bih. & Oriss.* **1** : 62, 1903), Gamble (*Fl. Madr.* **1** : 41, 1957, reprinted edition) and Mukerjee (*Bull. Bot. Soc. Beng.* **12** : 47, 1959) the flowers are yellow. Saxton & Sedgwick (*Rec. Bot. Surv. Ind.* **6** (7) : 245, 1918) report this plant from north Gujarat and state: 'the flowers vary from yellowish-pink to reddish-purple but never yellow'. Blatter & Hallberg (*J. Bombay nat. Hist. Soc.* **26** : 223, 1918) describe the flowers as 'pale-rose coloured with the tip of the keel petal and the crest darker'. Phatak & Oza (ibid. **55** : 593, 1958) state that the flowers collected in August-September from Pavagadh in Gujarat State were of the usual yellow colour, whereas in October some plants had rose- or red-coloured flowers and that the colour remained even when the flowers began to fade. They consider the latter as a red- or rose-flowered variant of *Polygala erioptera* DC.

In Blatter Herbarium there are several sheets of this plant from Saurashtra, Baroda, and Broach, and a few from Nasik, Deolali, Poona, Ahmednagar, Kolhapur, and Andhra; most of the sheets are collected between August and November and bear the remark: 'flowers pink, red, or pale purple'; occasional sheets have 'white' flowers. One sheet, collected from Poona by Razi on 7-7-1951, bears the remark: 'flowers yellow'. Ezekiel (No. 30458), who collected this plant from Poona on 22-8-1917, describes: 'flowers yellow fading pink'. Plants from Andhra collected on 10-7-57 have 'white or pinkish flowers' (Wagh No. 5994).

On several occasions the author collected the present plant from Baroda and Broach in Gujarat State, where it is fairly common among grasses during August-October. The flowers were invariably found to be pink, red, or pale purple; in no case were yellow flowers seen.

It would appear from the above data that the flowers of *P. erioptera* DC. when fresh may be yellow but later on turn pink, red, or even white. Such a change in colour is also observed in several plants, e.g. *Abelmoschus manihot* Medik., *Hibiscus lampas* Cav. It is worth while to make careful field observations on this point at different times during the flowering season in various localities to confirm if the change in colour is on account of the time of the year and the age of the plant or connected with some ecological factor.

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[1] Communicated by Professor P. V. Bole.

St. Xavier's College,
Bombay,
November 17, 1961.

G. L. SHAH,
M.SC., Ph.D.

24. OCCURRENCE OF *UTRICULARIA HIRTA* KLEIN IN SOUTH INDIA

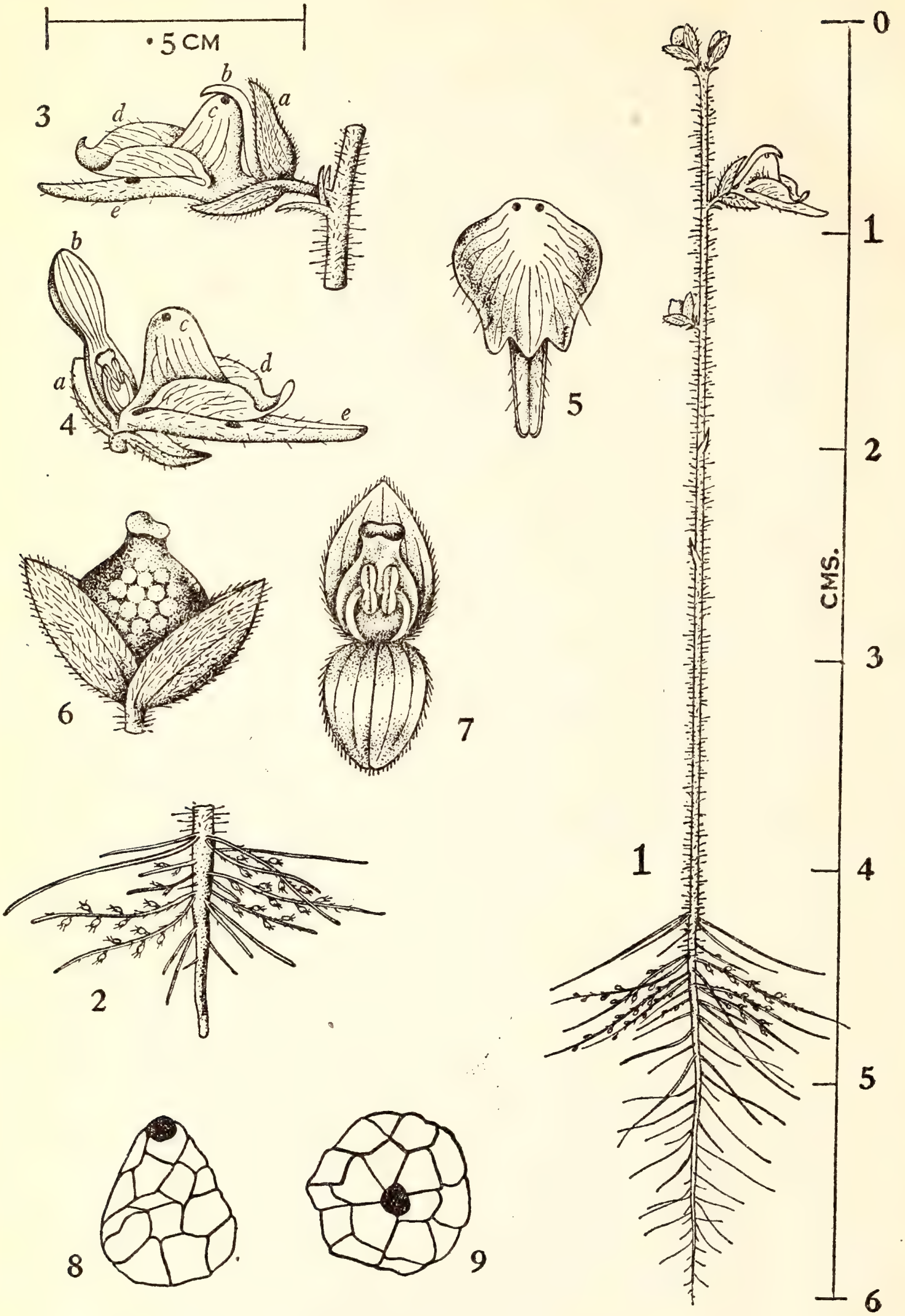
(*With one plate*)

Utricularia hirta Klein ex Link in Jahrb. 1 (3): 55, 1820; Oliver in J. Proc. Linnean Soc. 3 (12): 183, 1859; Hook. f. Fl. Brit. Ind. 4: 332, 1885.

This is a rare insectivorous plant collected by the junior author from Gingee Reserve Forests of Madras State at an altitude of *c.*115 m. during the botanical exploration tours of the Botanical Survey of India, Southern Circle. There is no authentic report of its occurrence in south India, nor has the taxon been described in any of the south Indian floras. In India, it is reported to have been collected previously at an altitude of *c.*650 m. from Giridih, Hazaribagh District, by Clarke and from Manbhum District by Campbell, both in Chota Nagpur, and at *c.*1000-1600 m. from Khasia mountains by Griffith (Hooker, 1885); Klein's collection of the species from Deccan Peninsula is not specific as to the exact locality. Because this interesting taxon has not been described in any flora of south India and the available description is incomplete in many respects, a detailed description is presented here.

The taxon has been found growing in abundance in two isolated spots only of the whole forest floor. It was in wet sandy soil near a rocky area but was not found on a rock surface or near a stream. The plants come up on wet, open, sandy soil, the pH of which varies from 6 to 5. They come up during the retreating monsoon from middle of September to December and complete their life cycle before the commencement of the next season. The leaves could not be collected, probably due to their ephemeral nature. A detailed description of the species is given below.

An ephemeral herb; *leaves* looked for but not found; *bladders* minute, pyriform, on the capillary structures (stolons) at the base of the scape, shortly stalked laterally; *stolons* minutely and sparsely hairy;



Utricularia hirta Klein

1. Entire plant; 2. Basal portion of scape with capillary structures bearing bladders; 3. Entire flower (side view); 4. Corolla showing position of essential organs at base of upper lip; 5. Lower lip of corolla with spur; 6. Fruit with persistent calyx; 7. Calyx lobes with gynoecium and androecium; 8 & 9. Seeds—side and dorsal views.

scapes slender, simple, 4 to 8 cm. high, rarely branched, densely hirsute all over ; 3- to 4-flowered, erect raceme with one or two sterile basal bracts ; *bracts* basifixed, minute, as long as or a little longer than the pedicels, hairy, bracteoles 2, both bracts and bracteoles linear, lanceolate, acute, and erect ; *flowers* *c.* 5 mm. short-pedicelled, semi-erect ; *calyx* 2-lobed, ovate, obtuse, hairy, persistent, spoon-shaped *c.* 2 mm. long and *c.* 2 mm. broad at the base, subequal ; *corolla* white or bluish-purple, deciduous, bilobed, upper lip oblong obtuse, constricted at the middle, well appressed and bent over the hump of the lower lip ; lower lip *c.* 3 mm. long and 4 mm. broad, sparsely hairy reflexed with a high hump, 3-lobed, mid-lobe smaller and tooth-like, side lobes auricular, acute, lobes slightly incurved, hump shows 2 yellow dots ; *spur* conically cylindrical, horizontal with a slight upward bend near the apex, a little longer than the lower lip and protrudes beyond the lower lip, sparsely hairy, blunt end is cleft, with 2 conspicuous yellow spots on the side ; *stamens* 2, in front of the ovary with short filaments ; *ovary* globular, *stigma* sessile, *ovules* numerous, placentation basal ; *fruit* 2 to 3 mm. globose, semi-erect with persistent calyx lobes ; *seeds* minute, numerous, brownish, rhomboid, reticulate.

The following are a few of the variations noted in the specimens collected from south India and the description given for the species by Oliver (1859). The scape is smaller and measures only 4 to 8 cm. while Oliver records a wide variation from 2.5 cm. to 15 cm. ; 3 or 4 flowers have always been found in south Indian species while the former record is ' often 1-2 flowered '. The upper lip of the corolla is oblong-obtuse, constricted at the middle, differing from the obovate or oblong-obovate or quadrately oblong characters described formerly. However, the species has been confirmed at the Royal Botanic Gardens, Kew, by Mr. Peter Taylor to whom we are grateful.

BOTANICAL SURVEY OF INDIA,
SOUTHERN CIRCLE,
COIMBATORE,
June 26, 1961.

J. JOSEPH,
K. RAMAMURTHY

REFERENCES

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Hooker, J. D. (1885) : The Flora of British India **4** : 332.

Oliver, D. (1859) : The Indian species of *Utricularia*. *J. Proc. Linnean Soc.* **3** (12) : 183.

25. A NEW SPECIES OF *JATROPHA* FROM SOUTH INDIA

(*With a plate*)

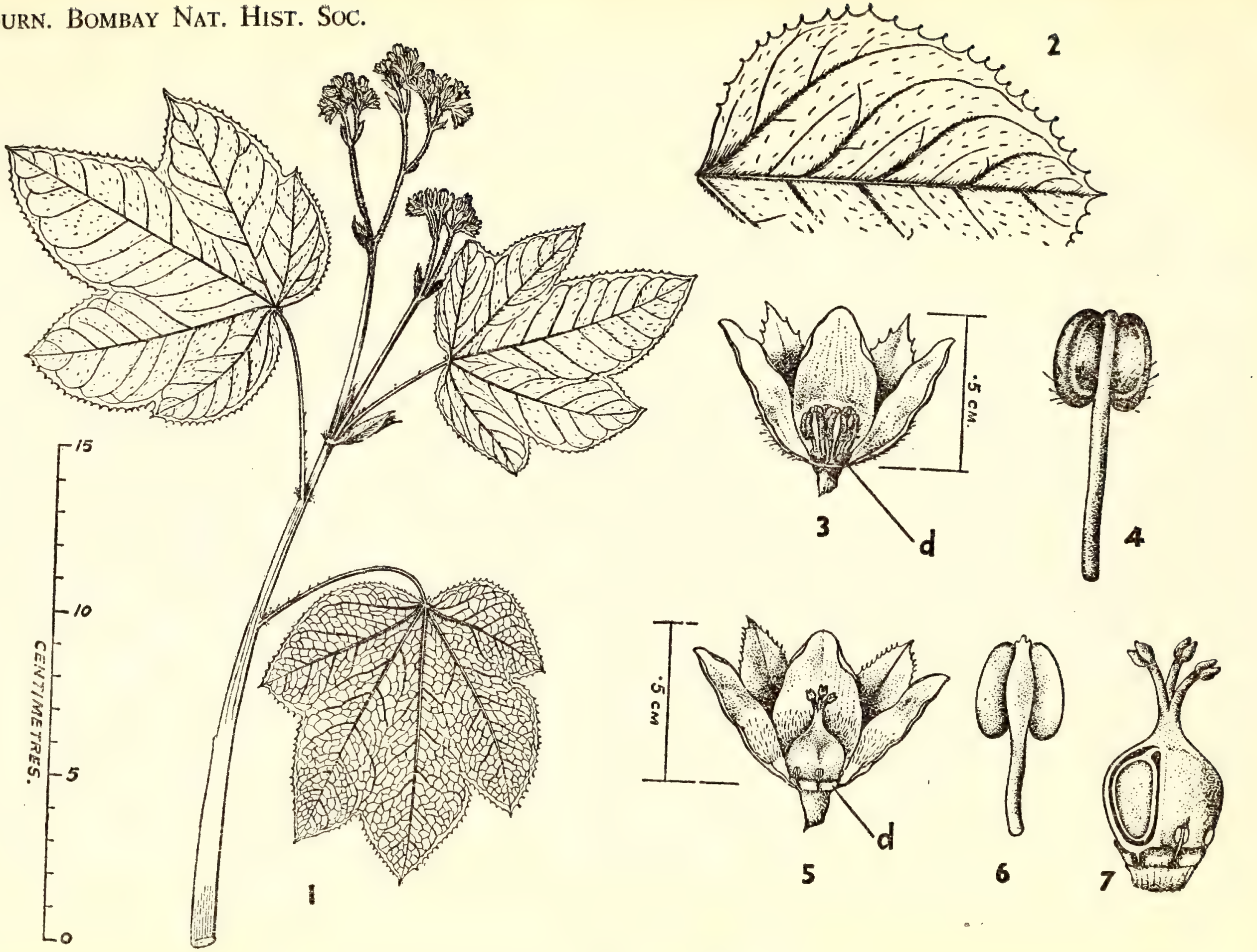
A new species of *Jatropha* collected at Kallimedu in Vedharanyam Forest, Tanjore District, Madras State, south India, is described.

Jatropha tanjorensis Ellis et Saroja, sp. nov.

Pertinet ad Euphorbiaceas Crotonoideas Cluytieas, affinisque est *Jatrophae glanduliferae* Roxb., a qua tamen differt foliis supra medium lobatis, stipulis brevioribus in segmenta filiformia ad apices glandulifera incisis, floribus polygamis, florum vero bisexualium petalis ad tertiam partem ex basi connatis.

Frutex glaber, puberulus tamen in juvenili conditione; caulis longus, robustus, dichotome ramosus. *Folia* simplicia, alterna, 7.5-11.5 cm. longa, aeque lata ac longa, palmatim 3-5 lobata supra medium, lobis late ovatis, acuminatis, marginibus distanter serratis, serrationibus singulis desinentibus in setam glanduliferam, sparse pilosa in utraque pagina, velutina ad utrumque latus nervorum nervulorumque, tenuiter cordata ad basim sinu tenui; nervi principes 7-9, eminentes; petioli 4.5-7.5 cm. longi, nonnullis capillis glanduliferis prope basim supra ornati; stipulae breves, ciliatae, singulae desinentes in capitulum glandulare. *Flores* polygami, corymbose cymosi, virides colore pallide rosaceo tincti; bracteae 6-20 mm. longae, 2-5 mm. latae, lanceolatae, acutae, capillis glanduliferis ad margines ornatae. *Flores* ♂ breviter pedicellati; calyx 5-lobus, quincuncialis, lobis liberis, ovatis, tenuiter serratis, ± 4 mm. longis, extus pilosis; corollae 5-lobae segmenta libera, contorta, obtusa, rotundata, ± 4 mm. longa; discus constans glandulis 5 minutis ad basim columnae staminalis sitis; stamina 8, libera; antherae erectae, basifixae, 5-7 capillis ornatae, connectivo prominenti, cellulis polliniferis ad utrumque latus positis. *Flores hermaphroditi* breviter pedicellati; calycis 5-lobi segmenta libera, 5-8 mm. longa, quincuncialia, pilosa ad margines serratos glanduliferos; corollae 5-lobae segmenta connata ad tertiam partem ex basi, 5-8 mm. longa, obtusa contorta, nervosa, intus pilosa; discus circum ovarium constans glandulis 5, levis; stamina 6-8 libera; antherae erectae, complanatae, basifixae, connectivo prominenti; ovarium superius, glabrum, triloculare, syncarpum, uno ovulo pendulo in unoquoque loculo; styli 3, singuli in duo stigmata furcati. *Fructus* non visus.

Holotypus, *Ellis* 11809 A, et isotypi, *Ellis* 11809 B-F, lecti a J. L. Ellis ad Kallimedu, in silva Vedharanyam dicta, in regione Tanjorensi,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Jatropha tanjorensis Ellis et Saroja, sp. nov.

1. Portion of a branch ; 2. Portion of lamina enlarged—abaxial surface ; 3. Tangential section of a staminate flower ; 4. Stamen of staminate flower ; 5. Tangential section of a bisexual flower ; 6. Stamen of the bisexual flower ; 7. Ovary cut open to show nature of ovule. d : disk.

in Statu Madras, in India meridionali die 20 januarii anni 1961, et positi in Herbario Bot. Surv. Ind. ad Coimbatore.

Jatropha tanjorensis Ellis & Saroja, sp. nov.

(Euphorbiaceae—Crotonoideae—Cluytieae), allied to *Jatropha glandulifera* Roxb., but differs in having leaves lobed above the middle, stipules shorter with a few filiform glandular-tipped divisions, flowers polygamous, and petals connate to one-third their lengths at the base in bisexual flowers.

Shrub glabrous, puberulous in young condition; stem long, stout, dichotomously branched. *Leaf* simple, alternate; lamina 7.5-11.5 cm. long and as broad as long, palmately 3-5 lobed above the middle, lobes broadly ovate, acuminate, the margins distantly serrate, each serrature ending in a gland-tipped bristle, sparsely hairy on both the sides, velutinous on either side of the veins and veinlets, base slightly cordate with a shallow sinus; main nerves 7-9, prominent; petioles 4.5-7.5 cm. long with a few glandular hairs near the base adaxially; stipules short, ciliate, each ending in a glandular head. *Flowers* polygamous, in corymbose cymes, green with pale pink tinge; bracts 6-20 mm. long, 2-5 mm. broad, lanceolate, acute with gland-tipped hairs on the margins. *Staminate flower* shortly pedicellate; calyx free, 5-lobed, quincuncial, lobes ovate, slightly serrate, *c.* 4 mm. long, pilose outside; corolla 5-lobed, free; segments contorted, obtuse, rounded, *c.* 4 mm. long; disc of 5 small glands at the base of the staminal column; stamens 8, free; anthers erect, basally attached, 5-7 hairs on the anthers, connective prominent with pollen sacs on either side. *Bisexual flower* shortly pedicellate; calyx free, 5-lobed, 5-8 mm. long, quincuncial; segments ovate, pilose inside with gland-tipped serratures on the margins; corolla lobes connate to one-third their length at the base, 5-lobed, 5-8 mm. long, segments obtuse, contorted, veined, hairy inside; disc of 5 glands around the ovary, smooth; stamens 6-8, free; anther erect, flat, basally attached, connective prominent; ovary superior, glabrous, trilocular, syncarpous, with one pendulous ovule in each locule; styles 3, each bifurcating into two stigmata. *Fruit* not seen.

Holotype, *Ellis* 11809 A, and Isotypes, *Ellis* 11809 B-F, were collected by J. L. Ellis at Kallimedu in Vedharanyam Forest, Tanjore District, Madras State, south India, on 20 January 1961. They were incorporated in the Southern Circle Herbarium, Botanical Survey of India, Coimbatore, south India.

ACKNOWLEDGEMENTS

The authors wish to express their thanks to the Director, Royal Botanic Gardens, Kew, England, for his help in comparing this species with the rest of *Jatropha* represented in Kew, and to Dr. K. M. Sebastine, Systematic Botanist in charge, Botanical Survey of India, Coimbatore, for his keen interest and kind encouragement throughout the present study. Thanks are also due to Rev. Fr. H. Santapau, S.J., Chief Botanist, Botanical Survey of India, Calcutta, for his constructive suggestions and rendering the diagnosis into Latin.

BOTANICAL SURVEY OF INDIA,
SOUTHERN CIRCLE, J. L. ELLIS
COIMBATORE, T. L. SAROJA
August 5, 1961.

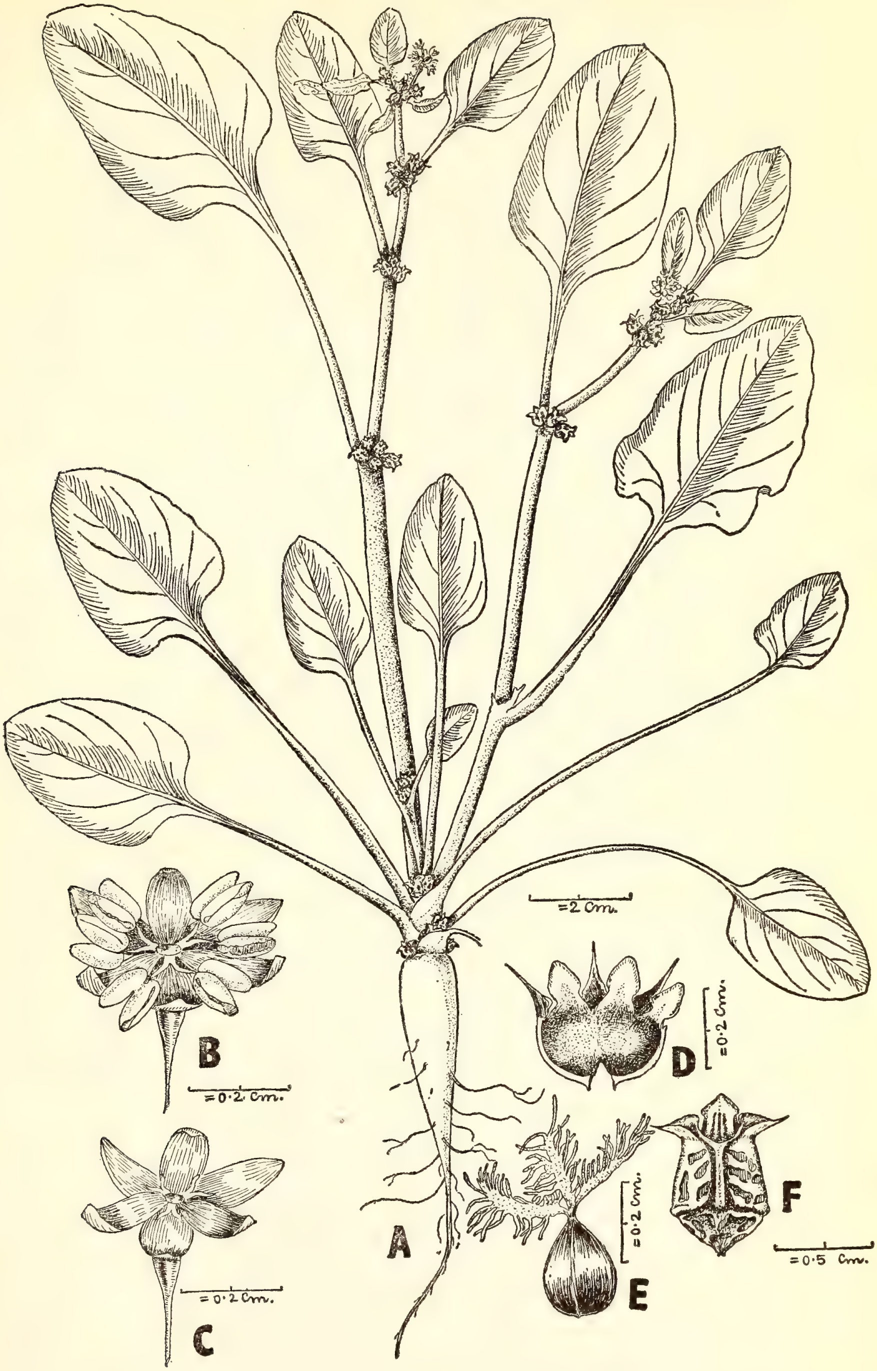
26. *EMEX SPINOSA* (LINN.) CAMPD. (POLYGONACEAE): A NEW RECORD FOR INDIA

(*With one plate*)

The genus *Emex* Neck. (Polygonaceae) has only two known species. One is *E. australis* Steinh., a native of South Africa, where it grows as a common weed by river banks and on damp ground. This species is kown to have spread in several parts of the world, e.g. Australia, where it has naturalised itself as a common roadside weed of certain regions. The second species, *E. spinosa* (Linn.) Campd. is said to be native of the Mediterranean region and is seen to grow as a very common weed, particularly in sandy waste places in Algeria, Egypt, Palestine, Crete, Greece, and Arabia, and is also known from Spain, Portugal, Sicily, Canaries, S. Africa, Australia, and Florida. This species is now being recorded for the first time in India, where it seems to have been a recent migrant from the Middle East countries.

Emex spinosa (Linn.) Campd.

Description. An annual, 20-80 cm. high, ascending or decumbent glabrous herb. Tap root 5-15 cm. long, more or less fusiform. Stems 1- many, 5-15 mm. thick, cylindrical, with longitudinal whitish streaks when green, sulcate and light brown when dry, sub-dichotomously branched — generally near base; nodes somewhat swollen, internodes up to 15 cm. long, rarely more; older stems fistular. Leaves 10-30 cm. long, radical and basal, cauline with much longer petioles — about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Emex spinosa Campd.

A. Whole plant (a small specimen); B. Male flower; C. Male flowers after shedding anthers; D. Dissected female flower showing inside of perianth-tube and position of inner perianth lobes; E. Pistil; F. Fruit (cauline) in face view.

two-third of the entire length; the petioles adaxially flat, much dilated at base, the bases persisting; lamina 4-10 by 3-6 cm., apex round, margins entire — sometimes undulate towards base, glabrous on both surfaces, veins prominent beneath. Ochrea silvery, membranous, tubular, soon becoming torn and jagged — ultimately lost at age. Flowers monoecious. Females usually forming axillary whorl-like clusters of (6-) 8-10 (-12) flowers, sub-sessile, those in axils of pseudo-verticillate radical leaves ('radical flowers') usually solitary, larger, and sessile; perianth green — a triquetrous tube with deep pitted obconic base and faces almost equal with a stout median ridge and similar pittings (the radical flowers have nearly truncate base and the outer faces broader and roundish with usually more than one ridge and excessive pittings — the outer two faces being proportionately reduced), 6-lobed, the lobes in two alternating series, outer three divergent with spinescent apices extending along angles of the tube; inner having lower halves erect with three prominent ribs, upper halves deltoid and converging to form an almost closed trigonous top. Ovary pink, trigonous, enclosed tightly by the perianth tube; stigmas large, extruding through the angles of the inner perianth. Male flowers in axillary clusters among the females — excepting radical clusters, or on short (up to 4 cm. long) axillary or leaf-opposed shoots — often with few female flowers at lower nodes, pedicellate — the pedicels 1-3 mm. long, slender; perianth segments (4-) 5-6 (more commonly 5) in two alternating series, 1.5-2.5 by .5-1.5 mm., elliptic-ovate, acute, sepaloid, outer three broader than inner. Stamens (6-) 5 (rarely 4) — when 6, a pair opposite each outer perianth segment but usually one or at times two reduced to solitary; anthers slightly extruding; filaments persistent. Fruit trigonous, brown, 5-7 by 4-5 mm., including the persistent perianth (now enlarged and much hardened); the radical fruits with perianth up to 9 by 6 mm. with the spines nearly blunt. Seeds trigonous with a pointed tip, brown, 3-4 by 2-3 mm., those of radical fruits proportionately larger.

Flowers and fruit: February-May.

V. S. Sharma 890 (Mall Rd., 2 March 1959): 1460 (Pushkar, 3 March 1960): 1676 (Adarshnagar, 8 March 1961). These are the numbers of the specimens collected by the author during his studies on the Flora of Ajmer (Rajasthan).

During the examination of a large number of locally collected fresh as well as dried specimens it was noticed that occasionally one or more, especially outer perianth segments in male flowers, are on the way to become quite thick and spinescent like those in the female flowers. Some abnormalities like cohesion of two radical flowers are also seen.

The species by now has naturalised itself well in the cultivated fields, especially of the sandy regions. Besides its occurrence in mostly wheat and barley fields, I have frequently seen the weed in beds of *Spinacia oleracea* Linn., where it generally remains stunted (probably due to regular plucking), resulting in the development of only radical leaves which make the plant similar in appearance to the vegetable crop. It appears that in the very near future, this species may spread to other parts of the country and become one of the most troublesome weeds, a possibility that is quite conceivable with its abundant fruits and owing to its adhesive perianth which provides an efficient means of dispersal. In my opinion, the probability cannot be ruled out that the present species may have already established itself in other sandy regions of the State and in regions of west and south Rajasthan during its migration.

I am greatly indebted to Dr. B. Tiagi, Reader, University Department of Botany, Jodhpur, for guidance and to Shri Bhim Sen, Principal, Government College, Ajmer, for providing all research facilities. I also express my sincere thanks to Shri M. B. Raizada, Officer-in-charge, Botany, Forest Research Institute, Dehra Dun, for Herbarium and library facilities.

DEPARTMENT OF BOTANY,
GOVERNMENT COLLEGE,
AJMER (RAJASTHAN),
October 30, 1961.

V. S. SHARMA

27. *CONVOLVULUS PLURICAULIS* CHOISY, A SYNONYM OF *CONVOLVULUS MICROPHYLLUS* SIEB.

While attempting to establish the botanical identity of Shankhapushpi, an important drug of indigenous medical practice, it was found that *C. microphyllus* and *C. pluricaulis* formed two of the five different sources of this drug. On further scrutiny of the literature, herbarium specimens, and authentic drug samples, we found it practically impossible to distinguish them from each other, and, therefore, suggested [1961, *Ind. Jour. Pharm.* **23** (8) : 223-224] that the two species should be merged into one. The fusion could not be accomplished then as the type material could not be examined, and so we sought the help of the Director, Royal Botanic Gardens, Kew, for examining the type material in their herbarium. The opinion of the Kew authorities based on the type duplicates of both the species has confirmed our earlier findings. They say: 'The distinctions suggested by Clarke (Hooker's, 1885, FL. BR. IND. **4** : 218) between the widespread *C. microphyllus*, extending from Egypt to India, and *O. pluricaulis*, which has only been identified as occurring in India and Pakistan, do not appear to be tenable. It would seem that all the material should be referred to a single variable species for which the correct name would be *C. microphyllus*. Detailed study would be required to establish whether varieties should be recognised, but in the Indian material none are readily distinguishable.'

The nomenclature of the Indian plant described under these two names is given below:

Convolvulus microphyllus Sieb. ex Spreng. Syst. 1: 611, 1824.
Syn. *C. pluricaulis* Choisy, Convol. Or. 95, 1834.

The authors are grateful to the Director, Royal Botanic Gardens, Kew, Richmond, Surrey, for his kind help.

BOTANY DEPARTMENT,
ST. XAVIER'S COLLEGE,
BOMBAY,
November 28, 1961.

P. V. BOLE
VIRBALA SHAH

Notes and News

Toxic Chemicals

The increasing use of toxic chemicals for the protection of agricultural crops in India requires attention to be drawn to an aspect that may be overlooked or noticed too late—the destruction of wild animals and birds caused by these chemicals. Lovers of nature have long been seriously concerned about this menace to wild life. Indisputable evidence, in the shape of post-mortem analyses of dead birds and animals collected from different parts of England, has recently been furnished by a Joint Committee of the British Trust for Ornithology and the Royal Society for the Protection of Birds. As a result of the activities of this Committee and criticism, both in Parliament and in the press, a complete ban has been placed on the use for spring sown grain of seed dressings containing dieldrin, aldrin, heptachlor, and in the other seasons their use is permitted only for autumn and winter wheat 'where there is real danger of attack from wheat bulb fly'. It is hoped that this matter will be carefully considered by our Central and State Governments before long-term programmes are undertaken in this country.

* * * *

Red Goral

In Miscellaneous Note No. 4 at page 792 above a reference is made to a bright red goral recently described from the Mishmi Hills in Assam. Members resident in that area and others who have the opportunity are requested to keep a look-out for this animal and to try and obtain a specimen for the Society's collection.

* * * *

Fall-out menace from Atom Bomb

In October 1961 the long-threatened atom bombs of gigantic proportions were tested by Russia on the island of Novaya Zemlya in the Arctic Circle, roughly 75° N., 56° E.

There have been several press reports in all parts of the world stating that, in addition to atmospheric contamination by radio-active material, the bombing tests have raised the possibility of migrating birds being affected and carrying the contamination to other parts of the world.

Enquiries have been received by the Society about the advisability of shooting and eating duck and other game birds which visit India during the cold weather.

With our present knowledge of bird migration and the wide distribution of many species, it was impossible to select any birds which would be known to come definitely from the affected area, but single specimens of the Common Pochard (*Aythya ferina*) and the Pintail Snipe (*Capella stenura*) shot in Nasik District, Maharashtra State, on 3 December 1961, were sent to Dr. A. R. Gopal-Ayengar of the Biology and Medical Divisions, Atomic Energy Establishment Trombay, Government of India, Bombay.

Analysis carried out at the laboratories of the Atomic Energy Establishment have revealed no traces of radio-active contamination in any of these birds or the three other duck received from Bharatpur. The Atomic Energy Establishment is keeping a close watch on the activity levels of migratory birds and any harmful indication will be brought to the notice of the public.

* * * *

M.Sc. Degree in Field Ornithology

We are glad to be able to announce that the M.Sc. degree in Field Ornithology (Zoology) has been awarded by the University of Bombay to Shri Vijaykumar C. Ambedkar, who worked for the degree at the Bombay Natural History Society under the guidance of Dr. Sálim Ali. The subject of his thesis was 'The Ecology and Breeding Biology of the Indian Weaver Birds with special reference to *Ploceus philippinus* (Linn.)'. Shri Ambedkar was the first student at the Society, which we believe is the first and only institution in India to be recognized for M.Sc. courses in Field Ornithology.

* * * *

New Building for the Society

In the Annual Report for 1960/61 (page 843 below) we referred to negotiations with the Ministry of Scientific Research and Cultural

Affairs, Government of India, regarding funds for the construction of a building to house the Society and its collections. The Ministry have sanctioned an initial grant of Rs. 1,50,000 to the Prince of Wales Museum of Western India, Bombay, for the construction of a building in their grounds, which is to be let to the Society for a nominal rent. The plans are under preparation and it is hoped to commence work soon.

ANNUAL REPORT OF THE BOMBAY NATURAL HISTORY SOCIETY FOR THE YEAR 1960-61

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Vice-Presidents

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Mr. K. J. Nanavatty, I.P.
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HONORARY SECRETARY'S REPORT FOR THE YEAR 1960-61

At the last Annual General Meeting of the Society, I presented a report for the year ending 31st August 1960. The present report covers the period of 12 months thereafter.

THE SOCIETY'S JOURNAL

Volume 57 was concluded and contained 3 articles on Game Sanctuaries and Wild Life Preservation, 8 on birds, 1 each on fish and molluscs, 2 on arachnids, 4 on insects, and 14 on botany. During the current year, only one part of Volume 58 has been issued ; we hope to catch up and issue the other two before long. The dearth of articles on general Natural History continues.

GENERAL

It is still not possible to report any definite progress regarding the negotiations with the Ministry of Scientific Research & Cultural Affairs regarding a grant for a new building for the Society in the Museum grounds.

The Society continues to assist Dr. Sálim Ali in the bird migration study project to which I referred in my last report. Some 7500 birds have been ringed in the four seasonal efforts which have been made and some 20% of them were migrants. Activities are being now directed to duck and grey quail and it is hoped that this will increase the chances of recovery. The World Health Organization have made an additional grant of $5000 and it should be possible to continue this work for some time.

In addition to several field trips into the Ghats near Bombay, members of the Society's staff were able to pay a short visit to Talewadi on the western borders of Belgaum District, in Mysore State. They have obtained several interesting bats and amphibians, some of which are welcome additions to our collections.

During the year, some 800 additions were made to our vertebrate collections—21 mammals, 132 birds, 108 reptiles and 540 amphibians. Interesting additions include among birds the Spiny Babbler (*Turdoides nipalensis*), and among mammals specimens of Wroughton's Freetailed Bat (*Otomops wroughtoni*) collected after a lapse of 50 years at Talewadi, the type locality. At the same place, specimens of *Taphozous theobaldi* which in India has so far been recorded only from Nimar, Madhya Pradesh, were obtained. The identified reptiles include *Oligodon juglandifer* and *Bungarus bungaroides* and the amphibians *Indotyphlus battersbyi* (a new genus and species from Khandala, W. Ghats), *Tylototriton verrucosus, Megophrys major, Aelurophryne mammata, Rana annandalli, Philautus annandalli, Ramanella montana, R. variegata and Kaloula pulchra taprobanica.*

The additional steel cabinets, ordered during the year, have also been received and with the exception of the skins of the larger mammals, it is hoped that our vertebrate collections will soon be properly arranged and become more easily accessible for examination and reference than they have been before.

During the year, 64 books were added to the Library which included 13 purchased, 7 received for review, and 44 presented; 30 journals have been bound, and 7 books rebound. We obtain 10 journals and/or magazines by subscription and 54 by exchange. The latter list is being revised and suggestions from members would be welcome.

PUBLICATIONS

The revised 6th edition of THE BOOK OF INDIAN BIRDS by Sálim Ali, and A SYNOPSIS OF THE BIRDS OF INDIA & PAKISTAN by Dillon Ripley were published in August this year. We have applied to the Ministry of Scientific Research & Cultural Affairs for financial assistance for THE BOOK OF INDIAN BIRDS and also to enable us to proceed with the publication of the 2nd edition of THE BOOK OF INDIAN ANIMALS, the typescript and pictures of which are ready.

The Ministry of Scientific Research & Cultural Affairs have authorised the Society to reprint a second edition of M. A. Smith's volume on Snakes in the FAUNA OF BRITISH INDIA series. This was published in 1943 but, after the first distribution in India, the stock was destroyed by enemy action in London. In the absence of any other work on this subject, the book is very badly needed in India. We hope to have it ready by the middle of next year.

NATURE EDUCATION

The Nature Education Scheme for children, financed by the Government of Maharashtra, is now in its 13th year. Tours of the Natural History Section of the Prince of Wales Museum and special talks on natural history subjects with the aid of exhibits and other specimens, films, and sometimes living animals, were continued and over 4500 children attended.

Eight field trips to different places in the Island of Salsette were arranged for members of Nature Study Clubs. The trips were followed by meetings at schools to help children to learn to collect and preserve specimens and to discuss items and topics experienced afield.

Three trips were arranged :

(*a*) To study the plant life of Khandala, led by Fr. H. Santapau ;
(*b*) To Bassein to study the geographical features of the area, led by Principal C. B. Joshi of Parle College ;
(*c*) To study the geology of the hot springs at Vajreshwari, led by Prof. R. N. Sukheswala.

The English edition of the 5th booklet OUR ANIMALS in the 'Glimpses of Nature' series will be available shortly. The editions in the other languages are under preparation. We cannot help referring to the poor sales experienced by the publications, in spite of the low price and large number of coloured illustrations included therein.

MEMBERSHIP

The total membership on our books at the end of 1960 was 1101 including 235 life and 6 honorary members. Of the others, subscriptions were received from 680 members up to the end of July this year, leaving 180 who had either not informed us of their desire to resign or could not be traced. During the 12 months, 85 ordinary members and 4 life members were enrolled as against 29 resigned and 5 ordinary and 2 life members who died during the year.

With funds made available by the Rockefeller Foundation, an illustrated brochure depicting the history and the activities of the Society has been prepared and sent to persons and institutions likely to be interested. We hope to show an increase in membership during the current and ensuing years.

REVENUE ACCOUNT, 1960

During the year under review, the income of the Society, excluding the special grant received from the Government of Maharashtra for the maintenance of the Reference Collections, was Rs. 45,409·06 as against Rs. 57,657·40 in the previous year. This drop of Rs. 12,224.64 was partly (Rs. 2529·32) on account of fall in the income from subscriptions during 1960 and mainly as our popular publications were out of print.

The operations of the Society during 1960 showed a deficit of Rs. 8966·43 as against Rs. 2221·49 in 1959. Expenses during the year amounted to Rs. 54,376·29 as against Rs. 59,878·89 in the previous year.

You will notice that the Balance Sheet shows our stock of books as worth Rs. 49,439·37. This represents the value of 8 publications of which three, viz. SOME BEAUTIFUL INDIAN TREES, BUTTERFLIES OF THE INDIAN REGION, and the Wall Charts for the Identification of Poisonous Snakes, account for over Rs. 40,000·00. 2000 copies of the Tree books were published in 1955, and though we sold 551 copies in the first year, the sales have dropped to 139 copies in 1960. Similarly, only 70 copies of the Butterfly book were sold during the year. Your Committee are considering ways and means of improving the rate of sale, but meanwhile we have to contend with a very slow conversion of stock into cash, and to this extent are handicapped in undertaking additional publications. Members are requested to assist as much as possible in the sales of the Society's publications.

STAFF

The Committee wishes to record its appreciation of the willing co-operation of the entire staff in the activities of the Society.

ACKNOWLEDGEMENT

The Committee's thanks are due to Mr. J. L. Bernard who continues to look after the Society's interests in the United Kingdom.

THE BOMBAY NATURAL HISTORY SOCIETY

THE BOMBAY PUBLIC TRUST ACT, 1950

SCHEDULE VII [VIDE RULE 17 (1)]

BALANCE SHEET AS AT 31 DECEMBER 1960

FUNDS AND LIABILITIES		Rs nP	Rs nP
Trust Fund or Corpus:			
Life Membership Fund:			
Balance as per last Balance Sheet ...		97,490.28	
Add: Amounts received during the year...		2,150.00	9,640.28
Other Earmarked Funds:			
Field Work Fund:			
Balance as per last Balance Sheet		1,959.97	
Expedition Fund ...		1,800.00	
Wild Life Fund ...		715.25	
Mammal Survey Fund:			
Balance as per last Balance Sheet	3,071.64		
Less: Spent during the year ...	743.66	2 ,327.98	
Building Fund:			
Balance as per last Balance Sheet	30,000.00		
Less spent during the year ...	850.00	29,150.00	
Nature Education Trophy Fund ...		500.00	
Reserve for Snake Wall Charts ...		3,000.00	
Unspent Grant of Government of Maharashtra:			
Transferred from Income and Expenditure Account:			
For Furniture and Equipment 1960-61	7,000.00		
Maintenance Grant 1960-61...	12,068.86	19,068.86	
Unspent Grant World Health Organization:			
Transferred from Income and Expenditure Account ...		3 ,029.93	88,551.99
Carried forward ...			1,88,192.2

ASSETS	Good	Doubtful	Rs nP	Rs nP
Immovable Properties				nil
Investments: ...				
Rs. 14,000 4% Bombay Port Trust Bonds			10,780.00	
,, 15,000 4% Bombay Improvement Trust Bonds ...			11,400.00	
,, 36,000 3% Funding Loan 1966-68 ...			35,812.62	
,, 25,000 3% Conversion Loan 1946 ...			25,000.00	
,, 2,000 3% First Development Loan 1970-75 ...			1,948.75	
,, 92,000 (Market value Rs. 82,797.50) ...			84,941.37	
£ 460 3½% Defence Bonds ...			6,133.34	
At cost			91,074.71	
Less: Provision for Depreciation ...			3,750.00	87,324.71
Furniture and Fixtures:				
Balance as per last Balance Sheet ...			1,048.16	
Add: Addition during the year ...			40.00	
			1,08 16	
Less: Depreciation during the year ...			136.02	952.14
Loans: (Secured)	*Good*	*Doubtful*		
Loan Scholarships	nil	nil		
Other Loans (to staff) ...	175.00	nil		175.00
Advances:				
To Trustees			nil	
,, Employees			515,00	
,, Contractors			,420.71	
,, Lawyers			nil	
,, Nature Education Scheme			1,964.41	
,, Others			453.57	10,382.69
Carried forward ...				98,834.54

BALANCE SHEET AS AT 31 DECEMBER 1960—(*continued*)

FUNDS AND LIABILITIES		Rs nP	ASSETS	Rs nP	Rs nP
Brought forward ...		1,88,192.27	Brought forward ...		98,834.54
Liabilities:			*Income Outstanding:*		
For Expenses (including purchases of Furniture) ...	41,536.06		Rent	nil	
,, Advances (Subscriptions) ...	848.10		Interest (Accrued)	12,70.50	
,, Sundry Credit Balances ...	270.94	41,655.10	Other Income:		
Income and Expenditures Account			Supplies and Services	8,514.30	
Balance as per last Balance Sheet	27,584.83		Government of Maharashtra Grant ...	4,000.00	
Less: Deficit as per Income and Expenditure Account	8,966.43	18,618.40	Government of India Grant	7,000.00	20,784.8
			Stock of Books on hand: (At cost or under) As certified by the Honorary Secretary ...		49,439.37
			Cash and Bank Balances:		
			(*a*) *In Current Account with:*		
			National and Grindlays Bank Ltd., Bombay	45,884.17	
			National and Grindlays Bank Ltd., London (£612.19.4)	8,172.89	
			Fixed Deposit with the Chartered Bank, Bombay, (In the name of the Bombay Natural History Society)	25,000.00	
			(*b*) With the Trustee	...	
			(*c*) With the Cashier	350.00	79,407.06
Total ...		2,48,465.77	Total ...		2,48,465.77

The above Balance Sheet to the best of my belief contains a true account of the Funds and Liabilities and of the Properties and Assets of the Trust.

(Sd.) SURENDR LALL,
Trustee

As per our report of even date.
(Sd.) A. F. FERGUSON & CO.,
Chartered Accountants

BOMBAY, 6*th June*, 1961

THE BOMBAY NATURAL HISTORY SOCIETY

THE BOMBAY PUBLIC TRUSTS ACT 1950

SCHEDULE IX (VIDE RULE 17 (1))

Dr. *INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31 DECEMBER 1960* Cr.

EXPENDITURE	Rs nP	Rs nP	INCOME	Rs nP	Rs nP
To *Expenses in respect of Properties:*			*By Rent:* Accrued	nil	
Rates, Taxes, Cesses, Repairs, and Maintenance	nil		Realised	,,	nil
Salaries	,,		,, *Interest* (Realised and Accrued)		
Insurance	,,		On Securities	3,252.66	
Depreciation (by way of provision or adjustments)	,,		On Bank Account	1,295.14	4,547.80
Other expenses	,,	nil	,, *Dividends*		nil
,, *Expenditure from Grants:*			,, *Donations*		
Government of Maharashtra—Maintenance Grant 1959-60			In Cash	nil	
Salaries 2,939.69			In Kind	nil	
Rent 250.00			Specific Donation by Mr. Loke Wan Tho	20,000.00	20,000.00
Miscellaneous 5,126.84	8,366.53		,, *Grants:*		
Maintenance Grants 1960-61			Government of Maharashtra-unspent Maintenance Grant for 1959-60 as per last Balance Sheet ... 11,656.83		
Salaries 11,405.23			Maintenance Grant for 1960-61 ... 40,000.00		
Rent 15,750.00			Less-Adjustment on account of unspent grant for 1959-60 3,290.30 36,709.70		
Miscellaneous 775.91	27,931.14		(Expended as per contra) 48,366.53		
	36,297.67		Grant for Educational Activity 1960-61 ... ... 4,000.00	52,366.53	
Unspent Balance for 1960-61: Transferred to Balance Sheet	12,068.86	48,366.53	Government of Maharashtra for purchase of Furniture and Equipment		
Government of Maharashtra-for purchase of Furniture and Equipment-out of Grant for 1959-60	16,148.54		Balance for 1959-60 unspent as per last Balance Sheet 16,174.29		
Unspent Balance for 1960-61 transferred to Balance Sheet	7,000.00	23,148.54	Grant for 1960-61 7,000.00		
World Health Organization-for Bird Migration Survey Expenditure during the year ... ... :	,066.07		Less-Adjustment on account of unspent grant for 1959-60 25.75 6,974.25	23,148.54	
Unspent Balance transferred to Balance Sheet	30,029.93	38,096.00	(Expended as per contra)		
Rockefeller Foundation-Expenditure during the year (including Rs. 15,759.93 for purchase of Furniture and Equipment)		30,864.72	Government of India for Journal Expenses-1960-61	7,000.00	
Expenditure from Specific Donation by Mr. Loke Wan Tho:			World Health Organisation-for Bird Migration Survey ... ... (Expended as per contra)	38,096.00	
Cost of Station Wagon	19,362.46				
Expenses of Registration, Insurance, etc.	637.54	20,000.00			
Carried forward ...		1,60,475.79	Carried forward ...	1,20,611.07	24,547.80

Dr. INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31 DECEMBER 1960—(*continued*) Cr.

EXPENDITURE	Rs nP	Rs nP
Brought forward ...		1,60,475.79
To ***Establishment Expenses:***		
Salaries (including Dearness Allowance)	21,227.98	
Society's contribution to Staff Provident Fund	1,079.00	
Postages	1,352.56	
Printing and Stationery...	1,409.46	
Advertisement	103.00	
Editor's Travelling Allowance	400.00	
Honorary Secretary's Travelling Allowance	3,000.00	
Telephone call charges	503.29	
Bank charges	160.06	
Electric charges	169.16	
Meeting Expenses	159.26	
Conveyance to Staff	188.00	29,751.77
Remuneration to Trustees		nil
Remuneration (In the case of Math) ...		nil
Legal Expenses		nil
Audit Fees		750.00
Amounts written off:		
Bad Debts	nil	
Loan Scholarships	nil	
Irrecoverable Rents	nil	
Other Items (Stock of Books-Circumventing the Mahseer and other Sporting Fish)	215.19	215.19
,, *Miscellaneous Expenses:*		
General Charges	1,031.08	
Fire Insurance	110.30	
Custom Duty etc. on specimens received from U.S.A.	182.87	
Donation to Zoological Survey of London	66.43	1,390.68
,, *Depreciation:*		
On Investments	nil	
,, Furniture	136.02	136.02
,, *Expenditure on* ***Objects of the Trust:***		
(*a*) Religious		
(*b*) Educational—Journal Expenses ...	20,811.86	
—Library Account ... (Subscription to other Societies)	595.00	
—Purchase of Books ...	475.95	
—Periodicals and binding charges	249.10	
(*c*) Medical relief	nil	
(*d*) Relief of Poverty	nil	
(*e*) Other Charitable Objects	nil	22,131.91
Total ...		2,14,852.08

INCOME		Rs nP	Rs nP
Brought forward ...		1,20,611·07	24,547.80
By *Grants* (cont'd)			
Rockefeller Foundation—			
Balance unspent as per last Balance Sheet ...	31,454.42		
Less—Unspent balance forfeited	589.70		
(Expended as per contra)		30,864.72	1,51,475.79
,, *Income from other sources:*			
Subscriptions		19,043.83	
Entrance Fees		445.00	19,488.83
,, *Publications:*			
Journal Sales		3,727.55	
Books etc., Profits:			
Book of Indian Birds		109.04	
Some Beautiful Indian Trees... ...		618.67	
Some Beautiful Indian Climbers and Shrubs		1,206.31	
Butterflies of the Indian Region ...		412.66	
Game Birds of India, Burma and Ceylon Vol. III		179.80	
Indian Molluscs		94.05	
Snake charts		865.07	
Calendars		2,961.17	
Other Publications		182.41	10,356.73
,, Commission on Taxidermy work ...			16.50
,, Deficit carried to Balance Sheet ...			8,966.43
Total ...			2,14,852.08

BOMBAY, *6th June, 1961*

As per our report of even date
(Sd.) A. F. FERGUSON & Co.,
Chartered Accountants.

For Bombay Natural History Society
(Sd.) SURENDR LALL,
Trustee.

THE BOMBAY NATURAL HISTORY SOCIETY

NATURE EDUCATION SCHEME

Receipts and Payments Account for the year ended 31 December 1960

RECEIPTS	Rs nP	PAYMENTS	Rs nP
To Balance as at 1st January 1960 brought forward	82.51	By Repayment of Advance from Bombay Natural History Society	965.64
,, Grant Government of Maharashtra 1960-61 ...	6,640.00	,, Salaries of Nature Education Organiser	5,640.00
,, Sales of Booklet No. I	411.06	,, Postages	78.94
,, Sales of Booklet No. II	417.72	,, Printing and Stationery	174.26
,, Sales of Booklet No. III	498.89	,, Cost of Booklet No. IV	3,233.00
,, Sales of Booklet No. IV	255.67	,, General Charges	96.76
,, Sales of Nature Study Pamphlets Line-drawings ...	12.06	,, Cash with the Cashier	50.00
,, Bombay Natural History Society (Advance) ...	1,953.41	,, Bank Balance on 31 December 1960	32.72
Total ...	10,271.32	Total ...	10,271·32

BOMBAY, *6th June,* 1961

(Sd.) A. F. FERGUSON & CO.,
Chartered Accountants.

MINUTES OF THE ANNUAL GENERAL MEETING OF THE BOMBAY NATURAL HISTORY SOCIETY HELD IN THE DURBAR (TOWN) HALL, BOMBAY, ON FRIDAY, 22ND SEPTEMBER 1961 AT 6 P.M., WITH MR. G. V. BEDEKAR, I.C.S. IN THE CHAIR

1. The Honorary Secretary's report for the year ending 31st August 1961 having been previously circulated to members was taken as read and adopted.

2. The Balance Sheet and Statement of Accounts presented by the Honorary Treasurer were approved.

3. The following were elected as members of the Executive and Advisory Committee for the year 1961 :

EXECUTIVE COMMITTEE

President

SHRI SRI PRAKASA, *Governor, State of Maharashtra*

Vice-Presidents

Major-General Sir Sahib Singh Sokhey, I.M.S. (RETD.)
Rev. Fr. H. Santapau, S.J.
Mr. Humayun Abdulali (*Hon. Secretary*)
Mr. Surendr Lall (*Hon. Treasurer*)

Ex Officio

Dr. D. V. Bal, M.SC., Ph.D.
Mr. G. V. Bedekar, I.C.S.
R. S. Dharmakumarsinhji
Mr. Z. Futehally
Mr. R. E. Hawkins
Dr. C. V. Kulkarni, M.SC., Ph.D.
Mr. D. N. Marshall
Mr. D. J. Panday
Mr. D. E. Reuben, I.C.S. (Retd.)
Dr. H. Trapido, M.D.

ADVISORY COMMITTEE

Mr. H. G. Acharya, F.R.E.S.	*Ahmedabad*
Mr. F. C. Badhwar, O.B.E.	*New Delhi*
Sir Chintaman Deshmukh, KT., C.I.E., I.C.S. (Retd.)	*New Delhi*

Rev. Fr. Dr. J. B. Freeman, M.A., L.T., Ph.D., D.D. ..	*Mysore*
Mr. E. P. Gee, M.A., C.M.Z.S.	*Shillong*
Dr. Baini Prashad, D.SC., F.N.I.	*Dehra Dun*
Mr. P. D. Stracey, I.F.S. (Retd.)	*Shillong*
Dr. M. L. Roonwal, M.SC., Ph.D., F.N.I., F.Z.S.I. ..	*Calcutta*
Lt.-Gen. Sir H. Williams, C.B., C.B.E., M.I.C.E., M.I.E.	*Roorkee*
Y. S. Shivrajkumar of Jasdan	*Jasdan*

4. The following Amendments to the Rules & Regulations of the Society, previously circulated with explanatory notes, were put to the vote and carried unanimously :

i. that the following paragraph be inserted at the end of the existing Rule 7 :

> ' It shall also be permissible for the Committee to decapitalize such investments and use the proceeds as revenue, provided that the market value of the capital remaining invested in Government Securities after such transaction shall not be less than the amount of the contributions and compounded subscriptions paid by the then existing Life Members and corporate members who have compounded their subscriptions.'

ii. that the following words be deleted from the existing Rule 25 :

> ' ....and printed in two newspapers published outside Bombay '.

5. The films BETWEEN THE TIDES and KEW GARDENS loaned by British Information Services were exhibited and greatly appreciated.

6. The meeting terminated with a vote of thanks to the British Information Services for the loan of the films, to the Asiatic Society for the loan of the premises, and to the Chairman of the meeting.

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18 CHURCH ROAD, VEPERY, MADRAS—8-2-1962. C6711
EDITORS: H. SANTAPAU & HUMAYUN ABDULALI

THE SOCIETY'S PUBLICATIONS

Mammals

The Book of Indian Animals, by S. H. Prater. With many coloured and monochrome plates. 2nd (revised) edition. (*In preparation*)

Birds

Game Birds of India, by E. C. Stuart Baker. Vol. III. Pheasants, 1st Edition. **Rs. 20**
(*Price to Members Rs.* 15)

The Book of Indian Birds, by Sálim Ali. With 64 coloured and many monochrome plates, 6th edition, revised and enlarged. **Rs. 25**
(*Price to Members Rs.* 20)

A Synopsis of the Birds of India and Pakistan, by S. Dillon Ripley II. An up-to-date checklist of all the birds resident and migrant, including those of Nepal, Sikkim, Bhutan, and Ceylon. **Rs. 25**
(*Price to Members Rs.* 20)

Snakes

Identification of Poisonous Snakes. Wall chart in English, Gujarati, and Marathi. **Rs. 10.**
(*Price to Members Rs.* 8)

Miscellaneous

Some Beautiful Indian Trees, by Blatter and Millard. With many coloured and monochrome plates. 2nd edition. Revised by W. T. Stearn. **Rs. 20**
(*Price to Members Rs.* 16)

Some Beautiful Indian Climbers and Shrubs, by Bor and Raizada. With many coloured and monochrome plates. **Rs. 22**
(*Price to Members Rs.* 17.50)

Butterflies of the Indian Region, by M. A. Wynter-Blyth. With 27 coloured and 45 monochrome plates. **Rs. 28**
(*Price to Members Rs.* 22.50)

Indian Molluscs, by James Hornell. With 2 coloured and many monochrome plates, and text-figures. **Rs. 6**
(*Price to Members Rs.* 4.50)

Glimpses of Nature Series Booklets :

1. OUR BIRDS I (with 8 coloured plates) in English, Gujarati, Hindi, and Marathi. **80 nP**
   Kannada **62 nP**
2. OUR BIRDS II (with 8 coloured plates) in English, Gujarati, Hindi, and Marathi. **62 nP**
3. OUR BEAUTIFUL TREES (with 8 coloured plates) in English, Gujarati, Hindi, and Marathi. **62 nP**
4. OUR MONSOON PLANTS (with 8 coloured plates) in English, Gujarati, Hindi, and Marathi. **80 nP**
5. OUR ANIMALS (with 8 coloured plates) in English. **Rs. 1.25**

Back numbers of the Society's Journal. Rates on application.

Obtainable from :

The Honorary Secretary,
Bombay Natural History Society,
91, Walkeshwar Road, Bombay 6.

Agents in England :

Messrs. Wheldon & Wesley Ltd.,
Lytton Lodge, Codicote, Nr. Hitchin,
Herts., England.

The Society will gratefully accept back numbers of the Journal, particularly numbers prior to Vol. 45, from members who may not wish to preserve them.

TERMS OF MEMBERSHIP

Life Members pay an entrance fee of Rs. 5 and a life membership fee of Rs. 500.

Ordinary Members pay an entrance fee of Rs. 5 and an annual subscription of Rs. 30.

The subscription of members elected in October, November, and December covers the period from the date of their election to the end of the following year.

MEMBERS RESIDING OUTSIDE INDIA

The terms are the same for members living outside India. Such members should pay their subscriptions by means of orders on their Bankers to pay the amount of the subscription, plus postage—in all Rs. 32.50—to the Society in Bombay on the 1st January in each year. If this cannot be done, then the sum of £2-10-0 should be paid annually to the Society's London Bankers—The National & Grindlays Bank Ltd., 26 Bishopsgate Street, London, E.C. 2.

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